WATERSHED WORK PLAN

RED BOILING SPRINGS WATERSHED

MACON AND CLAY COUNTIES, TENNESSEE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
and
FOREST SERVICE
JULY 1972

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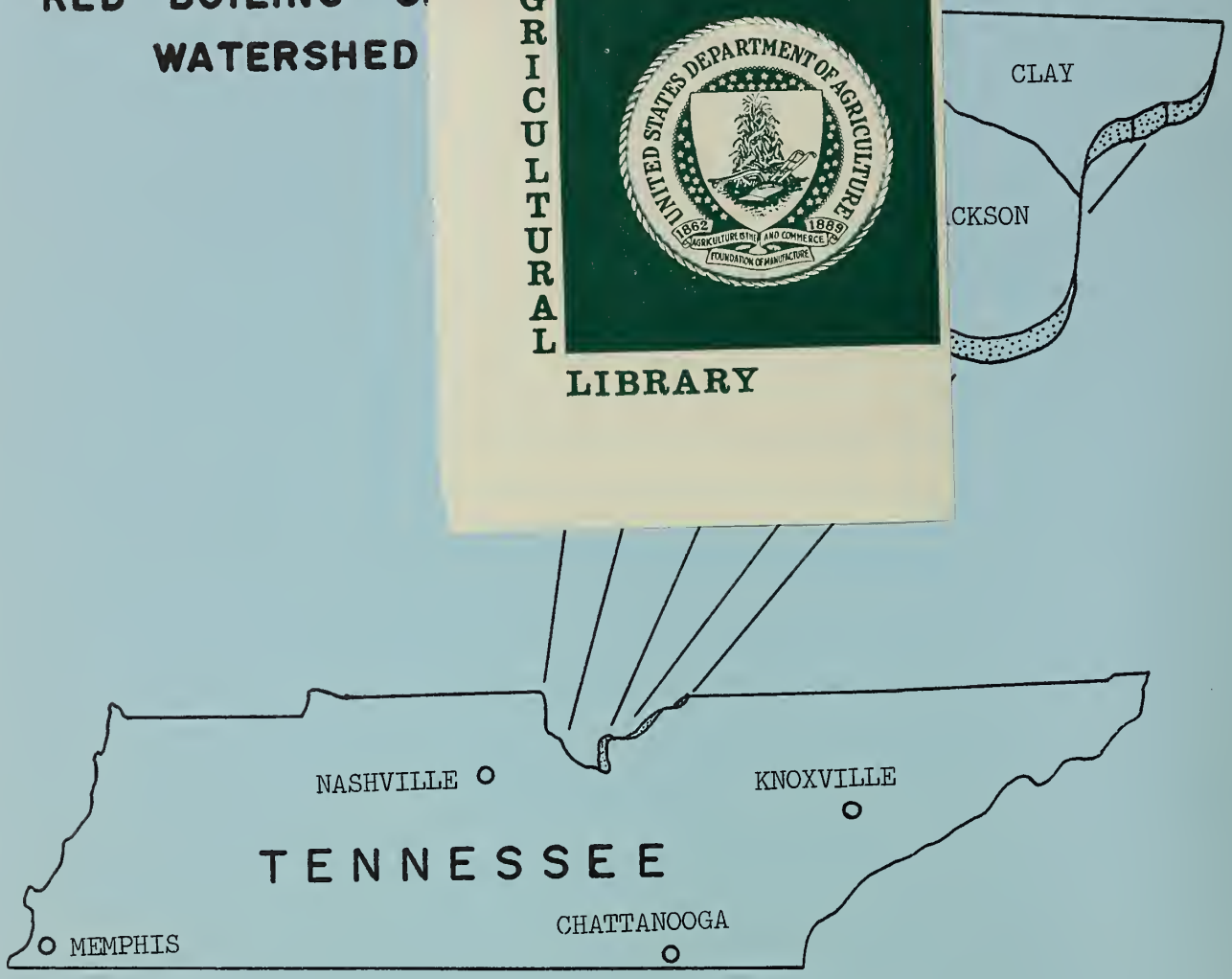

COVER: The cover picture depicts the peace and tranquility of the resort town of Red Boiling Springs being interrupted by the tragic flood of June 23, 1969. Photo of the Donoho Hotel courtesy of the Tennessee Planning Commission.

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WATERSHED WORK PLAN
RED BOILING SPRINGS WATERSHED
Macon and Clay Counties, Tennessee

Prepared under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Prepared by: City of Red Boiling Springs
Macon County Soil Conservation District
Clay County Soil Conservation District

With assistance by:

U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, Forest Service

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SUMMARY OF PLAN

This is a plan for watershed protection and flood prevention in the 9,650-acre Red Boiling Springs Watershed LOCATED within Macon and Clay Counties in Northeast Middle Tennessee. The plan was developed by the sponsors under authority of Public Law 566, as amended, with assistance from the United States Department of Agriculture, Soil Conservation Service and Forest Service. The SPONSORS are:

City of Red Boiling Springs
Macon County Soil Conservation District
Clay County Soil Conservation District

Salt Lick Creek is the primary stream and originates in Southeast Macon County and flows northwesterly through the city of Red Boiling Springs. It empties into the Barren River about 2 miles north of the Tennessee-Kentucky State line. Red Boiling Springs Watershed includes only the upper end of the Salt Lick Creek drainage area. The watershed is in the Appalachian Region of the United States and within the 14-county Hull-York Lakeland Resource Conservation and Development Association.

The city of Red Boiling Springs, a rural resort community of about 900 people, has a 127-year history of flooding. The social and economic growth of the community and surrounding area has not kept pace with the state nor the rest of the nation. Limited per capita income, job opportunities, business activities, and a marginal agriculture has caused outmigration of people. The population during the past 3 decades has had no growth.

Many problems have affected the social and economic growth of the Red Boiling Springs community. One of the primary PROBLEMS along upper Salt Lick Creek is severe flood damage to residential, commercial, public and industrial properties and farming areas from overbank flow. An average of $162,630 flood damage occurs each year.

The largest flood of record hit the community without warning and with unbelievable force on the morning of June 23, 1969. About 9 inches of rain fell on the 9,650-acre watershed area in about 8 hours with 7.3 inches of this rain falling in 5 hours. The swirling water that overflowed from Salt Lick Creek ripped up large chunks of asphalt pavement and tossed them around like pieces of styrofoam. At least 120

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automobiles and trucks and a Trailway bus were turned over, smashed, and swept downstream. At least 125 parcels of residential, commercial, public and industrial properties and 300 acres of farmland suffered extensive damage. Thirty-five homes and 15 business establishments were moved from their foundations.

The WORKS OF IMPROVEMENT designed to give relief to the flood problem along Salt Lick Creek will be installed during a 4-year period. The project measures to be installed are:

(1) conservation measures on 2,450 acres; and
(2) five floodwater retarding structures

The land treatment measures will be voluntarily planned and applied by the landowners in cooperation with the soil conservation districts. About 76 percent of the watershed will have an adequate land treatment program by the end of the project installation period. This includes 3,441 acres presently treated and 2,450 acres to be treated with the assistance of funds made available by this watershed plan. The estimated INSTALLATION COSTS of the project measures are:

Project Measures	Installation Cost (Dollars)		
	P.L. 566 Funds	Other Funds	Total Cost
(1) Conservation Land Treatment	10,000	111,300	121,300
(2) Five Floodwater Retarding Structures	1,287,600	343,000	1,630,600
(3) Project Administration	181,400	18,500	199,900
TOTAL PROJECT COST	1,479,000	472,800	1,951,800

The average annual BENEFITS to be derived from installation of the structural measures are estimated to be $169,090.

The project will benefit thousands of people including those who live, work or trade within this rural community, as well as tourists and the traveling public. It is estimated that 2,000 citizens now occupying or utilizing some 125 farms and about 150 parcels of industrial, commercial and residential property will be directly benefited.

Damage to residential, commercial, public and industrial property values from the 100-year frequency flood will essentially be eliminated and there will be no apparent risk of loss of life.

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Flood protection provided by the project will allow for the orderly social and economic growth and development of this rural resort town. The health and welfare of the citizens will be greatly enhanced. Private expenditures for repair of damages and replacement of losses can be used to increase standards of living. Public expenditures can be used to increase services. The project will protect tourist facilities and historic values and enhance the unique aesthetic values in this rural area.

The project will allow for the expansion of existing industries and attract new industries to the immediate area. Studies indicate that existing industries will install new equipment, expand outputs, and create many new jobs. New industries in the field of arts and mountain crafts are expected to locate here. The watershed project will help sustain the present 900 jobs and will create at least 160 new jobs. As new jobs are created the population will increase. The work force now migrating to other sections of the country in search of employment will be employed in local jobs.

The city of Red Boiling Springs will use its authority to install the proposed project measures and will be responsible for adequately PROTECTING, OPERATING AND MAINTAINING the structural measures. The estimated annual cost is $3,300.

The average annual benefits of $169,090 for the structural measures when compared with the average annual costs of $106,705 yields a benefit cost ratio of 1.6 to 1.

FEDERAL financial and technical ASSISTANCE will be furnished by the U. S. Department of Agriculture's Soil Conservation Service and Forest Service under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

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DESCRIPTION OF WATERSHED

Red Boiling Springs Watershed is located in Macon and Clay Counties, Tennessee, about 75 miles northeast of Nashville, Tennessee, and 50 miles southeast of Bowling Green, Kentucky. The watershed contains 9,650 acres or 15.0 square miles of the land in the headwaters of Salt Lick Creek. Salt Lick Creek originates in Southeast Macon County and flows northwesterly through the city of Red Boiling Springs and empties into the Barren River about 2 miles north of the Tennessee-Kentucky State line. The watershed encompasses the drainage area of Salt Lick Creek upstream from its confluence with Long Hungry Creek and is all in Tennessee.

Historical Data

Red Boiling Springs, according to legend, derived its name from the reddish water that boiled out of the ground around 9 or 10 o'clock each morning from one of the many springs in the valley. This truly unique feature of geography, geology and hydrology produced highly mineralized water with curative powers that attracted people from all sections of the United States and many foreign countries. Tourism has been the largest business in this small resort town although the waters no longer boil.

It is believed that digging wells, thus relieving some of the underground pressures and lowering the water table, is the reason these springs stopped boiling. 1/

About 1830, Edmund Jennings, while following well-worn animal trails in search of game, came upon a salt lick which gives the name to the creek that courses the valley. Wildlife in abundance had gathered to lick the salt which had dried on the rocks after being deposited there by streams fed by nearby springs. The original animal lick is located about 5½ miles north of Red Boiling Springs at a saline sulphur spring. Daniel Boone visited this spring and carved his name on a beech tree near it. The old tree is still living on the farm of E. E. Rhoads.

When Edmund Jennings visited the valley, he found a long established Cherokee Village under Chief Katawley and after returning home, told others of his find. Immediately, several families moved into the area. In 1840, Shepherd Kirby came with his family to make his home in the little settlement. He had suffered for years with a serious infection of the eyes. While hewing logs one day to build his home, the pain became so intense that he stopped work and went to a nearby spring hoping to relieve his suffering by bathing his eyes in the reddish, boiling water. The pain died away and the next morning his eyes were so much improved that he went again to bathe them in the same waters. Within a short time,

1/ Resources of Tennessee, by J. B. Killebrew and J. M. Gafford, published by the State of Tennessee in 1874.

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his eyes were entirely cured and the news quickly spread to other pioneer settlements of this wonder. This immediately brought others who sought to try the new cure of which they had heard such wonderful things. As the pioneers came on their westward movement, the spring's water was used in the treatment of every imaginable illness. Often times, the treatment resulted in cure for the disease-plagued victims. 2/

Medical doctors and other professional people from as far away as Boston, Massachusetts, and the state of Virginia visited the mineral springs, acknowledged the medical miracle, and recommended its use in the treatment of many diseases, such as gallstones, kidney stones, and other inflammatory conditions of the urinary tract.

Physical Data

The Red Boiling Springs Watershed lies in the Highland Rim area of Tennessee. The topography of the watershed is steep to rolling with variable ridge elevations on either side. Elevations around the rim of the watershed area range from about 900 to 1,035 feet above sea level. Salt Lick Creek confluences with Long Hungry Creek at elevation 708 (MSL).

The climate is excellent all year with an average annual temperature of 56 degrees that range from an average low of 34 in January to an average high of 80 in July. Normal annual precipitation is about 58 inches. Rains are heaviest in the late winter or early spring and the driest season in mid-fall. There are about 125 days throughout the year with measurable precipitation. Clear skies prevail on about 145 days during the year. The relative humidity averages about 70 percent. Nights are cool during the hot summer season.

The watershed is on the Northern Highland Rim physiographic provience of Tennessee. The area consists of narrow "V"-shaped valleys with steep hills and ridges. The ridgetops are remnants of the Highland Rim peneplain and are supported by residual chert of the Fort Payne Formation. This formation is predominantly a cherty limestone but contains layers of calcareous siltstone and shale. Green calcareous shale interbedded with crinoidal limestone is present locally near the base of the Fort Payne.

Stream valleys have cut down through the Fort Payne along most of Salt Lick Creek and its major tributaries exposing the underlying Chattanooga Shale. This formation is a black, carbonaceous shale containing frequent nodules of pyrite. The shale is about 20 feet thick and is underlain by Ordovician limestones.

2/ Red Boiling Springs Yesteryear a Spa--Tommorrow, by Tom Hammond, published by the Tennessee Conservationist, Volume XXXVI, February 1970.

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The geologic column representing the stratigraphic sequence of formations exposed or near the surface is as follows:

Geologic Age	Formation
Mississippian	Fort Payne
Devonian	Chattanooga Shale
Ordovician	Leipers

The watershed lies on the slopes of two structural highs or domes. Earth movements associated with the formation of the Nashville Dome to the South and a smaller dome about three miles east of Red Boiling Springs have caused the bedrock to dip in a northwest direction. As a result, the Chattanooga Shale outcrops along Salt Lick Creek for several miles. These earth movements have also caused some jointing of the bedrock.

Ground water is an important natural resource in the area. The Fort Payne Formation is the principal aquifer providing water for domestic use. The green shale section in the lower part of the formation and the underlying Chattanooga Shale act as partial barriers to the downward flow of groundwater. Several perennial springs occur near the contact with these less permeable shales. This "freestone" water is not highly mineralized and some of the larger springs provide the entire water supply for the city of Red Boiling Springs.

The highly mineralized sulfur water for which the area is famous is generally associated with the Chattanooga Shale. Groundwater which comes in contact with the shale moves along the surface in the direction of the dip of the rocks. Only a small portion of the water is able to penetrate the shale by moving slowly along joints and cracks. Apparently, the longer the water has been in contact with the Chattanooga Shale, the more mineralized it becomes. Solution of pyrite, an iron sulfide mineral in the shale, causes the formation of hydrogen sulfide gas which gives a rotten egg odor to the sulfur water.

"According to tradition, there are five different types of water in Red Boiling Springs: (1) Freestone water comes from Fort Payne chert and has not come in contact with the Chattanooga Shale; (2) white sulfur water contains a small amount of hydrogen sulfide gas and is water which has had some contact with the Chattanooga Shale; (3) black sulfur water is obtained directly from the Chattanooga Shale and is highly mineralized and contains large concentrations of hydrogen sulfide gas; (4) red sulfur is apparently an intermediate water between white and black; and (5) double and twist water is extremely mineralized, black sulfur water which has been in

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contact with the Chattanooga Shale for a long time. Double and twist, according to the oldtimers in the area, received its name from the fact that when it is drank, it causes the drinker to double over and twist around." 3/

Soils of the watershed are divided into three general soil associations.

Ennis-Lobelville-Humphreys Association

This association occupies the flood plain. The soils are on the nearly level bottoms or gently sloping terraces lying at slightly higher elevations above the bottoms. Some of the flood plain is used for house sites and urban uses. Most of the pastureland and row crops in the flood plain are in the northern half of the watershed.

Bodine-Frankstown Association

This association occupies the hillsides above the flood plain. The soils are well- to excessively-drained and cherty. Slopes range from moderately steep to very steep but most of the association occupies slopes of about 25%. Most of these soils are in woodland, pastureland, and small areas of row crops.

Mountview-Dickson-Frankstown-Bodine Association

This association occupies the gently sloping to sloping ridges above the steep hillsides. Ths soils of the association are the well-drained Mountview, the moderately well-drained Dickson, and the well- to excessively drained Bodine and Frankstown.

Forestry

Slightly over a third of the watershed, or 3,405 acres, is in forest cover. Except for the 40 acres of scattered woodland in the flood plain, all the forest cover is upland hardwood, generally occupying the steeper slopes and narrow valleys so characteristic of this watershed. The ridgetops are generally in agricultural use; the better soils are found here. With few exceptions, species composition on the forest plots examined is beech-sugar maple and oak-hickory forest types. Yellow poplar readily invades

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3/ The Black Shale and Double and Twist by John M. Wilson and John M. Kernodle, Geologists, Tennessee Division of Water Resources, published by the Tennessee Conservationist, Volume XXXVI, February 1970.

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the more open and sunlit sites. Virginia pine is native but only occasionally present, and then only on the higher and drier sites. It is not an important species in the watershed.

All but 400 acres of the forest lands are in small farm holdings, averaging somewhat less than 20 forested acres per tract. The small portion of forest land acreage not on farms is located in and near the community of Red Boiling Springs and is privately owned -- often held for speculation. No State or National Forest lands are located in the watershed.

The hydrologic conditions of the forest sites examined rated 20 percent good, 30 percent fair, 40 percent poor, and 10 percent very poor. The average hydrologic condition class is fair and this fact alone is a pretty sound indication that the woodlands are gradually recovering from past abuses such as woodland grazing, burning, and destructive logging practices. No recent fire and very little grazing damage is occuring in the watershed forests.

Economic Data

Red Boiling Springs has a long heritage as a resort town. Its mineral waters have been famous for nearly 100 years, but is losing its appeal to the wonder-drug generation. The loss has been partly responsible for the sagging economy. Mineral water was the big appeal during the pre-World War II boom and it still remains as an attraction today. Tourism was about the only industry in the community. People from all sections of the nation flocked to the nine spacious hotels and more than a dozen rooming-houses where the famed, smelly water with its touted curative power could be consumed. The rooming and eating facilities were once adequate to accommodate about 1,800 to 2,000 people.

Tourists provided a readily available market for practically all the farm products grown in the area. The farm population was oriented toward the production of food that could be used by the hotels and roominghouses such as country hams, vegetables, milk, butter, eggs, frying chickens, and watermelons. The labor force was fully employed almost year-round either entertaining their guests or preparing for the coming season. In fact, many seasonal employees were imported to help prepare and serve the sumptuous meals family-style in the spacious dining rooms.

The end of the era can be linked to the end of World War II when Americans wanted to kick up their heels a bit as living became faster. The end of the boom period caught the community before the economy became diversified. Today, two of the spacious hotels are still operating seasonally and one year-round. The first impression one might obtain is a quiet little village with a friendly and comfortable atmosphere with only the clanging of dinner bells at mealtime. It is a place for tourists to relax -- not a place to participate in a variety of frenetic recreational pursuits that leave a person exhausted. It is said that with several days taking it easy with mineral baths and massages, a swim or a sociable card game, tensions and pressures disappear and the body and mind are refreshed and invigorated. Tourists over the years have adopted a motto--to walk slow, to sit loose, and to fall asleep when you worry.

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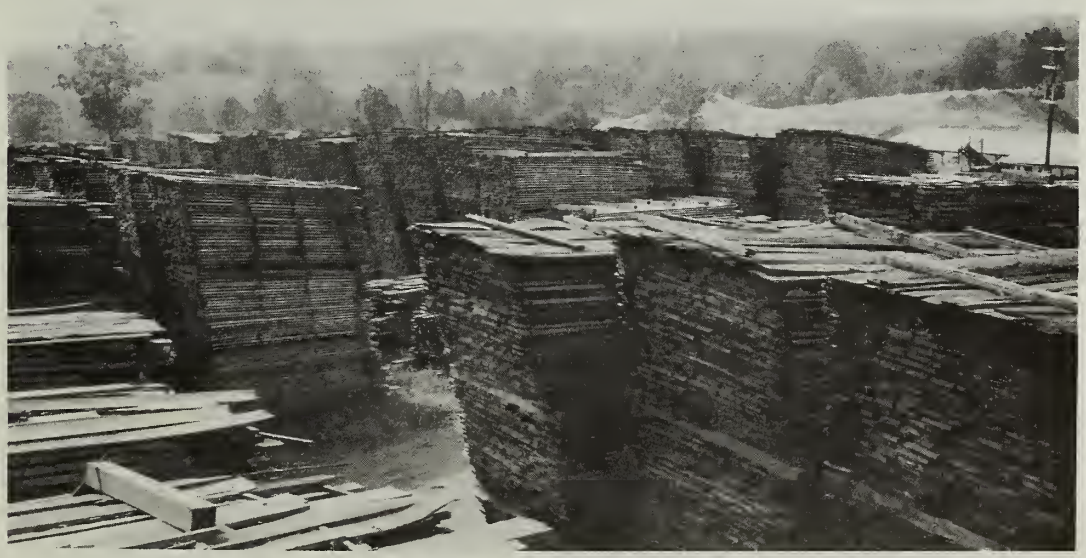
The economy is more diversified today than in the twenties through the forties. Some small industries employ the bulk of the labor force and the farming area is not dependent on the tourist trade. A large percent of the labor force moved from the area during the late forties and early fifties to seek employment in one of the larger metropolitan areas. Out-migration of the young and better educated natives still plagues the community. The resort community still has three big influxes of tourists per year. The 150 rooms in the three spacious hotels are booked to almost capacity. Older tourists in small groups still vacation and relax in Red Boiling Springs for short periods of time.

The population of the watershed is about 1,400 people with about 900 of these living within the corporate limits of Red Boiling Springs. About 80 percent of the employment in industry is women and 20 percent men. The remaining labor force is underemployed.

Ten sawmills and a pallet mill are located in the watershed. The farm forests have had an impact on the economy of Macon County for several years. All of the 163 farms contain some forest lands. Farm forests average about 20 acres per farm.



The timber industry in Macon County and surrounding area contributes substantially to the economy and employment of its people. The ten sawmills in the vicinity of Red Boiling Springs furnish employment for about 250 men.

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Despite this convenient market, or perhaps because of it, interest in forest management, although expanding, is still low. The mere presence of a timber market tends to "pressure" the average forest farmer into selling his timber crop as soon as it becomes merchantable, rather than allowing the timber volume and quality to develop to valuable maturity. While growing stock abounds, stands of mature, high quality trees are rarely found in this watershed.

Present hardwood sawtimber volumes average about 1,800 board feet per acre. Hardwood pulpwood volumes run about 3 cords per acre. Growing stock amounts to over 800 cubic feet per acre. All of the stands examined are medium to well stocked with good timber producing and soil building species. However, only a third of these stands are of sawtimber size. The site capabilities of the forest land are excellent. The recent acceleration of fire protection and forest management efforts implemented by the Tennessee Division of Forestry, supplementing the services provided by the Appalachian Forest Improvement Association, should raise the existing forest stands up to a level of production of high quality forest products that could treble the present volumes.

Sassafras roots stacked for drying form the nucleus for a unique tea and jelly processing plant. Underemployed farmers receive income from marketing sassafras roots.

The community of Red Boiling Springs is persistently pursuing a program to rejuvenate and enhance the rustic tourist attractions of the area.

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The Macon Garment Factory employs about 300 from Red Boiling Springs and surrounding area.

The agricultural economy is tied primarily to the production of cultivated crops, livestock and livestock products. The major crops produced in the watershed are corn, tobacco, small grain, silage, hay, and pasture. Tobacco is the main cash crop but the major source of farm income is livestock and livestock products. Income from the sale of timber is estimated to be less than 5 percent.

The hardwood forests provide a unique and basic aesthetic and recreational resource which can and should be further developed and proclaimed as a vital part of the "relaxing mountain retreat" atmosphere. The community is aware of the forest possibilities and will continue to encourage the landowner to manage his forest land more effectively so that the forests can better protect and enhance the water, timber, recreational, and aesthetic qualities of the Red Boiling Springs ecosystem.

The average value of agricultural products sold is less than $2,500 on 60 percent of the farms in Macon County. About 28 percent are in the low income or economically depressed category with the value of agricultural products sold being less than $1,000 per farm. Estimates indicate that conditions and trends in the agricultural economy of Macon County are representative for the watershed.

The boundary of the watershed lies within two Northeast Middle Tennessee Counties. About 99 percent of the watershed lies in Macon County and one percent or less is in Clay County. All land is under private ownership.

Present land use distribution is:

Land Use	Acres	Percent
Cropland	760	8
Pastureland	3,875	40
Forest Land	3,405	35
Miscellaneous	710	8
Red Boiling Springs	900	9
TOTAL	9,650	100

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Data from U. S. Census of Agriculture for Macon County is shown in the following table and approximates the watershed conditions:

Item	Unit	Year		
		1959	1964	1969
Number of Farms	Number	1934	1759	1641
Average Size of Farms	Acres	88	93	99
Average Per Acre Value of Land & Buildings	Dollars	86	126	188
Full Farmowners	Number	1079	1033	1235
Part Farmowners	Number	486	461	262
Average Age of Farm Operators	Years	50	52	52
Operators Working Off Farm 100 or More Days Per Year	Number	376	389	592
Commercial Farms	Number	1221	1209	984
Class I	Number	-	-	7
Class II	Number	5	4	5
Class III	Number	15	33	69
Class IV	Number	121	199	209
Class V	Number	450	528	362
Class VI	Number	630	445	332

The potential for development of the many assets of the watershed and surrounding area is high. In reviewing the assets for possible development, the people appear to have the greatest potential. The labor force is about 90 percent native born with an average junior high school education and readily trainable. Workers are exceptionally eager to learn and have the ability to absorb training rapidly. Certain innate skills, particularly manual dexterity, appear to be inherited from pioneering ancestors trained in handcraft.

Transportation facilities in the watershed are adequate, with a good system of State and County roads. Supporting services are available, including electricity, gas, telephone service and water. Long-term capital for industrial development is not available at the local level and must come from outside lending agencies.

Markets for livestock and other farm products within the area are adequate; although shipping by truck to outside markets is common practice.

The average value of land and buildings per farm in the watershed is about $25,000. Land values in the upland areas of the watershed are about $200 per acre and about $500 per acre in the flood plain. Since the watershed is in the Appalachian Region, it is eligible to receive cost-sharing assistance and grants through the Appalachian Regional Development Act of 1965. The region's uneven past development has failed to provide the economic base for a vigorous, self-sustaining growth. The economic base has relied historically on a few basic industries and marginal agriculture. The people of the area with an abundance of natural resources have not shared properly in the Nation's prosperity. The public investment made under the Act will promote its development and economic security.

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Counties in which the watershed is located have been designated as eligible for assistance under the Public Works and Economic Development Act of 1965 (formerly the Area Development Act of 1961). The purpose of the Overall Economic Development Act is to promote cooperation between and among existing agencies, organizations, and individuals in planning, carrying out, and evaluating programs leading to greater development of resources.

Red Boiling Springs Watershed is within the 14-county Hull-York Lakeland Resource Conservation and Development Project. This RC&D project was approved for planning by the Secretary of Agriculture on November 10, 1965, under the authority of the Food and Agriculture Act of 1962. The overall objectives of the RC&D project is the orderly development, improvement, conservation and utilization of all natural resources of the area, including soil, water, forest, fish and wildlife in order to provide employment and other economic opportunities to all the people. Watershed protection, flood prevention, water resource management, and rejuvenation of tourism and development of the recreational potentials in Red Boiling Springs Watershed are some of the many project measures planned.

The Upper Cumberland Economic and Development Center, located at Cookeville on the Tennessee Technological University Campus, will contribute to industrial development. This center provides research, business analyses, and consultation to existing and new businesses. Its objectives are to raise the standard of living, improve family income, and to improve basic facilities needed for industrial development.

Red Boiling Springs is located near four large Corps of Engineers' reservoirs. They are Dale Hollow, 25 miles east; Barren River, 25 miles northwest; Cordell Hull, 20 miles south and Center Hill, 30 miles south. The area is a scenic wonderland of forest-covered hills and coves, perennial streams and bubbling springs. The area lacks accessibility and skilled labor to adequately develop its natural and human resources in competition with other regions in the national market.

Land Treatment Data

The entire watershed (9,650 acres) is serviced by the soil and water conservation districts of Clay and Macon Counties. About 3,448 acres in the watershed are now under a conservation plan, with an additional 3,902 acres receiving technical assistance under going district programs. Sixty-six landowners are active cooperators in the district programs. Fifty-five farms in the watershed have conservation plans and forest management planning has been done on twenty-seven farms in the watershed. About 50 percent of the needed conservation treatment measures have been applied on the land in the past 10 years with district and other agency assistance. The cost of applying these measures is estimated to be about $161,900. (See Table 1A). Costs of the forest land treatment measures accomplished during the last 5-year period is about $1,200.

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Effective fire protection is provided by the Division of Forestry of the Tennessee Department of Conservation in cooperation with the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. Other available Federal-State forestry programs provided by the Division of Forestry include Cooperative Forest Management, Reforestation, General Forestry Assistance, and Cooperative Insect and Disease Control.

The additional forestry technical assistance recently provided by both the Division of Forestry of the Tennessee Department of Conservation and the Appalachian Forest Improvement Association under the Hull-York Lakeland RC&D Association is already providing the much needed spark of interest in forest management in the watershed. The impetus to forest management in an area where wise agricultural land use is already the rule should result in improved forest management and protection practices. This trend to better forest management is expected to yield better forest hydrologic conditions. Since the present program of forest management is adequate and expected to improve, no accelerated forest management program under P. L. 566 is proposed.

For example, the forest management measures installed under the existing cooperative forest programs during the installation period are estimated to be 120 acres of tree planting, 80 acres of release, 350 acres of harvesting assistance, and 300 acres of livestock exclusion.

Fish and Wildlife Resource Data

A major portion of the watershed is open land which is about eight percent cropland and 40 percent grassland. About 35 percent of the area is wooded and is located mostly on the steep slopes at the upper and surrounding edges of the watershed with a small amount along the main channel in the flood plain. Several large springs are located in the watershed that cause the main stream channel and several tributaries to have perennial flow.

Stream fishery is found downstream from the city limits of Red Boiling Springs. This comprises about 2.5 stream miles of channel. Trout have been stocked for the last five to six years beginning one mile below the

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city limits. The channel bottoms are estimated to be about 30 percent bedrock, 10 percent boulders, 20 percent rubble, 29 percent gravel, and small percentage of clay, sand, silt, and mud. There are approximately 2.2 miles of stream channel within the city limits. Most of these channels have been cleared and enlarged since the major flood in 1969. Approximately two miles of channel upstream from the city limits to the two proposed structure sites No. 4 and No. 5 have also been cleaned. These channels are now predominantly bedrock and gravel with habitat suitable for only minnows and small fish.

The rabbit population is high with a moderate to low hunting pressure. Squirrel population is moderate with a high hunting pressure. The abundance and hunting pressure for quail is high.

WATERSHED PROBLEMS

The resort town of Red Boiling Springs, a rural community of about 900 people, has a 127-year history of flooding. The social and economic growth of the community and surrounding area has not kept pace with the rest of the nation. Limited per capita income, job opportunities, business activities, and a marginal agriculture have caused outmigration of people. The population in this community during the past three decades has had little or no growth in number.

Red Boiling Springs is a quiet and peaceful community during times of no flooding.

But the tranquility is destroyed and the community becomes isolated by damaging floods.

The severe flood problem with present conditions along upper Salt Lick Creek results in damages estimated to be $162,630 annually. The average annual flood damage to residential, commercial, public, and industrial property values is $106,020; roads, bridges, and streets $6,840; crops and pasture $3,330; other agricultural $220; sediment $1,720; erosion $170; and indirect $44,330.

The following photographs of the June 1969 flood damage exemplifies the severity of the problem in this rural community. Land is damaged by overwash of gravel; cash crops are destroyed; homes are washed from their foundations; businesses are closed; health services are curtailed; home furnishings are water-soaked; county roads, bridges and streets are damaged; automobiles, trucks and other vehicles are destroyed or damaged; churches are destroyed or damaged extensively by water or debris; there are sanitation problems; and public services are disrupted.

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Land damage from gravel overwash is more destructive than the flooding that destroyed the corn.

Tobacco accounts for almost 50 percent of the total farm income in this section of the Appalachian Region. This crop was nearly destroyed by floodwater.

The home above was swept from its foundation and lodged across the creek in some trees along the stream. The house below is typical of damage to a dozen other homes on June 23, 1969.

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Service station pumps served as brakes for a home washed from its foundation and floated more than a block down the street.

Asphalt pavement from the parking lot and streets was piled five layers deep in front of the Palace Rest Home. Floodwater carried the pickup truck downstream about a half mile where it lodged on the chair ramp of the rest home. Practically all of the lawn and shrubbery was destroyed as floodwater entered the Palace.

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The water-soaked chairs, sofas, rugs, and other furniture in these homes are direct damages from a nightmare of raging floodwaters on June 23, 1969.

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This is typical flood damage to city and county roads and bridges.

Floodwaters picked up automobiles and asphalt pavement and tossed them like pieces of styrofoam.

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The bus and pickup truck were washed downstream almost a half mile. The bus had been parked at one of the hotels in the resort town.

Howard Ellis is observing flood damage to a new 1969 Plymouth. Estimates indicate that 35 new cars and 85 used cars were destroyed by a single flood on June 23, 1969.

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Newly furnished and redecorated church received extensive flood damage. Note water-soaked song books and debris in pews. The raging floodwater almost overtopped the pews. Another church was completely destroyed.

This cafeteria was closed to the public. This is a typical scene in Red Boiling Springs immediately after the rampaging floodwaters swept through town. Loss of business and sanitation problems are economic damages to small businessmen.

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Most of the 56 patients in the relatively new Palace Rest Home remained in bed all day as floodwater rose to depths of 6 to 18 inches above the floor. Note the turtle in the window and debris and mud on the floor. Cleanup and sanitation is a problem.

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The "mail went through", but was delayed past noon. About 9 inches of floodwater entered this new public service building on June 23, 1969.

The Wagonwheel Skating Rink was converted to a cafeteria to serve disaster victims and volunteer workers meals during rescue and cleanup operations after the June 23, 1969 flood.

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This is Red Boiling Springs about 10 a.m. on June 23, 1969. Rescue squads, ambulances, civil defense teams, and local citizens were busy aiding in the rescue of flood victims.

As the floodwaters subsided, the Macon County Health Department moved into town to give typhoid and tetanus injections.

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Volunteer workers sort clothing
donated to aid flood victims.

The expression on Mr. Edgar Hagan's face as he
reviews the ruins seems to ask the question--
What is the destiny of our resort town?

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....hope still lives.

A copy of the GROUP ACTION PLAN for Resource Conservation and Development of the Red Boiling Springs Community survived the June 23, 1969 flood. The plan was developed by the Red Boiling Springs Community Development Association through the Hull-York Lakeland Resource Conservation Development Association and cooperating County, State, and Federal Agencies.

The objectives of the local Water Resource Committee were to provide watershed protection and flood prevention. A Type I Water Resource Survey was prepared in September 1967 for the Salt Lick Creek Watershed under authority of Section 206 of the Appalachian Regional Development Act. The report recognized that a serious flood hazard did exist in the city but disaster struck the community before any relief could be obtained.

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Floodwater Damage

Red Boiling Springs has a 127-year history of flooding. Some portions of the urban area will begin flooding following a rainfall of about 2.0 inches within 24 hours.

Flooding of the agricultural area from small or medium storms occurs on an average of about two or three times per year. Floods large enough to cause damage to residential, commercial, or industrial property occurs about once every five years. The largest known floods in Red Boiling Springs occurred:

May 19, 1842	August 20, 1900
May 12, 1932	July 25, 1936
March 9, 1939	January 7, 1946
June 28, 1960	June 15, 1961
February 26-27, 1962	March 11-12, 1963
July 29, 1964	June 23, 1969

The following table shows the damage in dollars and the amount of water flow (cubic feet per second) that could be expected with various size floods in the future without the watershed project.

Frequency (Years)	Date of Historical Flood	Amount of Flow (CFS)	Depth of Water Over Low Point in Valley 1/ (Feet)	Damage ($)
500	June 1969	16,500	8.0	887,000
100	No Occurrence	10,500	6.1	587,000
25	January 1946	7,900	5.0	400,000
10	February 1962	5,800	4.0	220,000

1/ Reference for the low point in valley is north of the U. S. Post Office or Valley Section No. 37 shown on the project map.

High water marks and other information handed down from oldtimers indicate that flood crests may be getting higher. The four floods remembered by residents in the community as being the most devastating occurred on August 20,1900, January 7, 1946, February 27, 1962, and June 23, 1969. Using the February 1962 flood crest as a reference, the January 1946 flood was one foot higher and the June 1969 flood was four feet higher than February 1962. The crests of the floods in May 1842 and August 1900 were thought to be higher than the flood of January 1946 but lower than the June 1969 flood. People now live in constant fear of the possible recurrence of a much larger flood.

The largest flood of record hit the community without warning and with unbelievable force on the morning of June 23, 1969. About nine inches of rain fell on the 9,650-acre watershed area in about eight hours with 7.3 inches of this rain falling in five hours. The swirling water that overflowed from Salt Lick Creek ripped up large chunks of asphalt pavement and tossed them around like pieces of styrofoam. At least 120 automobiles and

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trucks and a Trailway bus were turned over, smashed, and swept downstream. At least 125 parcels of residential, commercial, public, and industrial properties and 300 acres of farmland suffered extensive damage. Thirty-five homes and 15 business establishments were moved from their foundations. The "Nashville Banner", an evening newspaper, gave the following account of this flood in the June 23, 1969 issue:

NASHVILLE BANNER - June 23, 1969

"TWO RED BOILING SPRINGS CHILDREN MISSING IN FLOOD"

6-10 Not Accounted for As Yet -

We are about as sure as we can be that two children were washed away, Red Boiling Springs Mayor Willis Knight said today after high winds and heavy rain whipped floodwaters through this resort community. A woman thought to be the mother of the two missing children, Mrs. Grady Bilbrey, was washed from her home and stranded in the top of a tree. Rescue workers later reached her.

The Cumberland foothills community was part of a wide section of Middle Tennessee and Southwestern Kentucky lashed early today by the bellowing and blowing torrents of rain. Others were feared lost in the same area as Highway Patrol Sgt. Norman Farley confirmed reports that at least five persons were missing following the storm.

Mayor Knight said a total of six to ten persons were unaccounted for at noon. He said every business place in Red Boiling Springs was damaged by the flood. Water a foot deep stood in the Palace Nursing Home there, but there were no injuries reported and no one had to be evacuated.

A man grabbed the safety of a tree as his home was washed away, one report indicated. Another was that several persons were said to have been in one home which was taken by the rushing water. By mid-day though, Mayor Kinght said most of the flood-water was gone. During early hours of the day, Red Boiling Springs was cut off to highway traffic and telephone and electrical services were disrupted...."

The two young girls were swept from their mother's arms and drowned as she attempted to carry them from their home to safety. The mother was washed downstream and clung to a tree branch for 3 hours before she was rescued. The young Bilbrey son (age 5) and his dog were trapped inside the home as the floodwater rose to a depth of 78 inches. They rode the whirling floodwaters to safety on a matress as debris rushed through the home almost capsizing his raft several times.

Damage to personal property was extremely high. Knee-deep mud settled on floors of stores and homes as the floodwater receded. Health hazards plagued many of the flood victims. There was evidence of high blood pressure, heart conditions, fever, diarrhea, sore throats, tension, mental and

physical fatigue throughout the Red Boiling Springs community. Many of the flood victims had to live with friends and relatives until their homes could be repaired or rebuilt.

President Richard M. Nixon declared the flood stricken North-Central Tennessee area a "Major Disaster" on July 12, 1969. This declaration permitted federal aid under the Federal Disaster Act, Public Law 81-875. The Office of Economic Preparedness (OEP) coordinated federal assistance. Damage was severe throughout the area but the Red Boiling Springs community was the hardest hit.

Although the 1969 flood was tragic, other historic accounts show large floods have occurred about 20 times since 1900. Excerpts from various newspapers give the following accounts of flooding in this North-Central Tennessee community.

THE MACON COUNTY TIMES - January 10, 1946

"MOST DISASTROUS FLOOD IN 100 YEARS VISITS COUNTY -

Not since May 19, 1842, has so much rain fallen in so short a time as fell over much of Tennessee on Sunday night, so far as records show.

On May 19, 104 years ago, a flood visited the section, doing immense damage and destroying a number of lives. On Sunday, the weather was warm with a gentle south wind blowing. About 9 o'clock that night, flashes of lightning could be seen in the south. A little later, rain began to fall and it fell almost without a letup all night, coming down in torrents, with lightning flashing almost continually and there being hardly a moment when no thunder could be heard. Much of the thunder was heavy and evidently followed lightning that had struck some object on earth.

Wash tubs 10 inches deep were found full of water on Monday morning with nobody able to tell how long they had been full. This meant that 10 inches or more of rain had fallen, which is a record in this part during a century of time. Oldtimers say that they never heard so much thunder before in one night's time and none of us can recall the falling of so much rain in 9 or 10 hours. Streams soon began to leave their banks, rising higher and higher. In fact, they were higher generally speaking over the county than any living person ever saw them before. In Red Boiling Springs, the waters were at least 2 feet higher than ever before known by any citizen of the place....

At Red Boiling Springs, the damage was estimated to be at least $50,000, with many homes flooded and furnishings damaged or ruined. One man with about $1,500 worth of furniture offered to sell it all for $100. He also lost some $300 in currency in the floodwaters...."

THE MACON COUNTY TIMES - March 1, 1962

"RAIN SENDS CREEK FLOODING, WATER GETS IN BUILDINGS -

A total of 6.87 inches of rain fell in the Lafayette area during the past 6 days, with 5.55 inches Monday and Tuesday sending creeks out of banks and into some homes and business building in the county....

In Red Boiling Springs, approximately a dozen homes had water in them either during the night Monday or Tuesday morning. The homes were located along the lake road in lower Red Boiling Springs....

Water surrounded the Church of Christ and the Church of God on North Springs Road in upper Red Boiling Springs. Downtown, it entered the Red Boiling Springs Dairy Dip and surrounded Roger's Resturant; both on Highway 52. Also, along Highway 52, the creek washed out butane gas tanks at the auto lot of Scott Wood, it was reported Tuesday. Heavy damage to Red Boiling Springs streets was also reported...."

THE MACON COUNTY TIMES - March 14, 1963

"Heavy Rains Monday Send Creeks, Branches Out of Banks in County -

Creeks Described at Highest Level Since 1946....

In Red Boiling Springs, Salt Lick Creek was rampaging and the water threatened some buildings. Although, it never climbed high enough to damage any buildings. In places, Red Boiling Springs streets near the business district were too deep in water to ford. Some families were evacuated from their homes as the water climbed, it was reported...."

THE MACON COUNTY NEWS - March 5, 1964

"Typcial March Weather Sends Rain, Wind and Tornado Threats -

A 2-inch plus downpour of rain hit the county late yesterday following scattered showers that fell most of the day and sent some creeks out of banks and several drainage ditches overflowing into roads. At Hillsdale, Goose Creek was across the old road which was impassible about 7:30 p.m. Also, streets were flooded in Lafayette and Red Boiling Springs...."

THE MACON COUNTY TIMES - May 12, 1932

"Storm Strikes County -

A heavy wind and rain storm struck the county Sunday morning about 10:00 o'clock, doing a large amount of damage. However, no person or livestock were injured but many buildings were

unroofed and two or three barns were blown down. Lands were badly washed in places and roads were damaged by the high waters. Hail was reported in some places over the county. Telephone service was cut off in numerous sections and the full amount of damage has not yet been learned...."

Owners of the bottom land report that average crop yields have been suppressed by the frequent occurrence of floods. The following table shows the percent land use distribution, flood-free yields and estimated percent yield losses.

Land Use	Percent Distribution	Flood-Free Yield	Estimated % Yield Loss
Tobacco	1	2,000 lbs.	30
Corn	11	85 bu.	20
Pastureland	34	7.4 AUM's	19
Forest Land	7	-	-
Miscellaneous (Urban)	47	-	-

Although flooding has depressed the value of the approximately 500 acres of flood plain land, the value ranges from $200 and up for land used primarily for agriculture. Land values in the built-up area start at $1,000 per acre. Since there is a large demand for land, all the owner needs to do is assign a price and someone will buy it.

Other agricultural damage within the flooded area consists of livestock losses, damage to fences, watergates, farm bridges, and damage to drainage systems by the accumulation of debris and sediment. The cost of repairing this damage is often higher than the complete replacement cost.

Damage to roads within the flood plain consists of siltation of drainage ditches, scouring of shoulders, washing of gravel, washing away segments of earth fill, breaking up asphalt paving, and erosion of portions of the roadbed and fill beneath the surface. Bridge damage consists of loss of bridge and/or damage to the abutments, piers, and approaches.

Erosion Damage

Cultivation of row crops on rolling and steep upland soils and the lack of adequate cover on some of the pasture and forest lands have contributed to the loss of top soil in the watershed. Some of the steep land which was formerly used for the production of crops was subjected to severe sheet erosion. This land has since become idle or has been converted to pasture land. The overall effect from the loss of top soil has been to reduce per acre crop and pasture yields.

Erosion damage to flood plain land occurs in the form of flood plain scour. Concentrated flood flows wash away the top soil leaving less productive scoured out areas in its place. Many of these scour channels are poorly-drained. They collect surface runoff and cause crops to drown out before they have a chance to mature. About five acres of scour channels are

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present on farmland in the benefited area of the watershed. The estimated average annual damage based on reduction in productive capacity is $170. These estimates of scour damage are somewhat misleading since some of the areas damaged by gravel overwash have previously been subjected to scour damage. These areas were taken into consideration in estimating sediment damages in order to avoid double counting of damages.

Sediment Damage

Damage from sediment in the watershed results primarily from the overwash of gravel on fertile flood plain soils. There is a gradual movement of gravel from the steep hill slopes into the water courses. During periods of peak stream flow, the gravel is moved downstream and deposited on the flood plain land by overbank flow. About 46 acres of the farmland in the benefited area of the flood plain have been damaged to varying degrees of severity by gravel overwash. Recovery of a portion of the former productivity of some of these lands can only be accomplished by removal of gravel deposits with heavy equipment.

Sediment is one of the major stream pollutants during periods of storm runoff. It is not only harmful to the fish habitat but is detrimental to the aesthetic value of the stream. Concentrations of gravel bedload materials in the stream at various locations have reduced channel capacities and tended to increase flooding in localized areas.

Indirect Damage

Indirect damages are associated with the direct primary damages. The losses are less obvious but are just as real and their effects are felt long after a flood has subsided. Indirect damages that occur are a result of disruption of employment, loss of production during flood periods, loss of business, interruption of the management and sales of products already manufactured, disruption of traffic, mail delivery, and school bus service, delay and inconvenience to the traveling public, and the interruption of management, feeding, disease control program, and marketing of livestock and livestock products.

Problems Related to Water Management

Farm Drainage: Farm drainage is not a major problem; however, the deposition of silt and other debris along the banks of the main stream and some tributaries impedes the return of surface water into the main channel. The main stem and most tributary channels have more than adequate capacities and depths for present drainage requirements but lack sufficient capacities for flood prevention.

Irrigation: Normal rainfall provides adequate moisture for production of crops presently grown throughout the watershed. Under normal conditions, no project action is needed to provide additional sources of water for crop irrigation. There is a need for additional farm ponds to facilitate an increase in the level of livestock and pasture management.

Municipal and Industrial Water: The present and future sources of municipal and industrial water have been investigated by consulting engineers and are adequate. The present water source for the city of Red Boiling Springs is a large spring located near the city limits that provides a supply of about 400,000 gallons per day. The average daily usage is about 75,000 gallons.

Fish and Wildlife: Water pollution appears to be detrimental to the fish habitat in Salt Lick Creek. Sources of pollution observed during the investigation were effluent from sawmill operations, waste water from laundries, and raw sewage from residential property.

Recreation: Farm ponds and a few private lakes are the only sources of water-based recreation within the watershed. Within a 30-mile radius of the watershed, there exists almost unlimited water-based recreation potential. Included are the Dale Hollow Reservoir, Center Hill Reservoir, Cordell Hull Reservoir and Barren River Reservoir. All are Corps of Engineers projects.

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PROJECTS OF OTHER AGENCIES

The Red Boiling Springs Watershed is located in the Green River Basin and comes under the purview of the Corps of Engineers, Louisville District. The Barren River Basin is a tributary of the Green River. The Corps of Engineers has been informed of the plans and progress made in this work plan development.

There are no other water resource development works of improvement (County, State, or Federal) now under construction of planned for future construction that will affect or be affected by the works of improvement included in this plan.

Salt Lick Creek is a perennial stream as it flows through town. Under natural conditions, the clear-flowing water has a faint murmuring sound created by the rippling and babbling effects as it travels its course toward Barren River. Plans to retain and complement this natural condition are under way by the Tennessee State Planning Commission under the authority of the Housing and Urban Development Act of 1965 which has developed a comprehensive plan for development and utilization of open spaces. The Open Space Program consisting of a 10-acre strip park and sidewalks along Salt Lick Creek has been oriented toward and designed to:

(1) complement and beautify the very unique natural characteristics of the town and its history as a resort;

(2) create a pleasurable experience as one strolls the 1/2 to 3/4 of a mile from one of the homes or hotels to the downtown business district.

The Department of Housing and Urban Development has approved a $77,180 grant for open space development in Red Boiling Springs. The funds are to be used to acquire land and to construct a 10-acre park with sidewalks throughout the city. Development will consist of shaping and cleaning the creek, building benches, fountains, covering existing bridges, spanning the creek at two locations, gazeboes, restrooms, small footbridges, and a kiosk.

PROJECT FORMULATION

Project formulation was based on the objective of restoring and improving the social and economic growth of this rural community. The city is persistently pursuing a program to rejuvenate and enhance the rustic tourist attractions that once flourished in the area. Measures that will improve, retain, restore, compliment and beautify the natural characteristics of this rural community are needed to accomplish their objective.

The major considerations in the selection of measures to complement or fulfill the sponsors' objective were the cause, amount and location of flood damages and needs for improvement. Flooding of residential, commercial, public and industrial properties occurs about once every 5 years and flooding of the agricultural areas about two or three times per year. The Soil Conservation Service and the Sponsors discussed the nature and magnitude of these damages so there would be a common understanding of the type and degree of protection that might be expected from any proposed flood control program.

Project formulation was based on the objectives agreed upon, which are:

(1) to prevent the possibility for recurrence of any loss of life;
(2) to eliminate the flood damages to residential, commercial, public and industrial properties in Red Boiling Springs from the 100-year frequency flood;
(3) to minimize damage to roads, bridges, city streets and other minor fixed improvements;
(4) to accelerate the rate of establishing soil and water conservation measures until 75 percent of the land is adequately treated;
(5) to maintain stream flow and water temperature;
(6) to reduce annual crop and pasture damage about 75 percent; and
(7) to improve the ecological and environmental conditions.

Proper land use and conservation treatment measures were considered a basic element in project formulation. An inventory of the watershed was made to determine:

(1) land use and land use adjustment needs,
(2) ground cover conditions and runoff characteristics,
(3) soil capability and production potentials for alternative uses,
(4) erosion rate and sediment yield,
(5) location of the critically eroding and high sediment producing areas needing stabilization,
(6) conservation treatment measures now on the land,
(7) forest protection available and management practices used,
(8) conservation treatment that needs to be applied,
(9) pollution hazards,

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(10) environmental improvement potentials,
(11) beautification needs, and
(12) economic conditions.

The inventory of the land use and conservation treatment revealed that:

(1) the present watershed soil loss averaged about 5.67 tons per acre,
(2) where adequate conservation treatment had been applied on the land the sediment yield averaged about 3.29 tons per acre,
(3) the present soil loss from cropland ranged from 7.7 to 21.7 tons per acre,
(4) critically eroding and high sediment producing areas needing stabilization were insignificant,
(5) about 290 acres of present cropland needs to be changed to permanent cover, and
(6) pasture and hayland improvement through proper management and renovation would reduce soil losses to a level adequate for sustained use.

The conservation needs, land use adjustments, physical characteristics and objectives of the sponsors were the criteria used in the selection of land treatment measures. Measures were selected that would protect and improve the soil and water resources on the individual farm and, also, provide a high degree of runoff retardation, erosion and sediment control, improve water management, aid in pollution abatement, and beautify and protect environmental conditions.

Six alternative conditions were studied in selecting structural measures. They are:

(1) Present - Condition of the watershed at the time of the survey and the base to which the proposed project is added.

(2) Future with Changes in Land Use and Conservation Treatment Measures - Land use and treatment measures were added to the first condition and evaluated based on the change in the hydrologic soil cover complex (change in runoff). These measures will reduce average annual flood damages about 9 percent.

(3) Future Changes in Land Use, Conservation Treatment Measures, Flood Plain Zoning, Flood Plain Acquisition and Flood Proofing - Flood Plain Zoning, Flood Plain Acquisition and Flood Proofing were added to the second condition to determine their effectiveness in reducing flood damages.

(4) Future with Changes in Land Use, Conservation Treatment Measures and Five Floodwater Retarding Structures - Five floodwater retarding structures were added to the second condition to determine their effectiveness in reducing flood damages.

(5) Future with Changes in Land Use, Conservation Treatment Measures and Four Floodwater Retarding Structures - Four floodwater retarding structures were added to the second condition to determine their

effectiveness in reducing flood damages.

(6) Future with Changes in Land Use, Conservation Treatment Measures and Six Floodwater Retarding Structures - Six floodwater retarding structures were added to the second condition to determine their effectiveness in reducing flood damages.

(7) Future with Changes in Land Use, Conservation Treatment Measures, Five Floodwater Retarding Structures and Minor Stream Channel Improvement - Improvement of the channel was added to the third condition to determine its effect in reducing flood damages caused by the 100-year frequency flood.

One alternative to providing flood protection would be to purchase the flood plain land and to convert the land use to grassland, woodland and parks for public use. Purchase of the flood plain land presently in urban uses would cost over 1 million dollars and would force families and businessmen to vacate their property which would be detrimental to the overall economy of the area.

Flood proofing of existing fixed improvements in the flood-prone areas was also considered. Flood proofing would cost over one-half million dollars and there would be a continued threat of loss of life on streets and sidewalks, interruption of business, and other damages which could not be effectively controlled by flood proofing. Flood plain zoning would not provide protection of existing properties that have been damaged from flooding. Future industrial, commercial and residential expansion would be precluded.

Channel improvement was considered as supplementary to floodwater retardation; however, studies revealed that minor improvement of the stream channel as a last increment would not significantly reduce flood damages. The main stream through Red Boiling Springs and tributaries are relatively clean and their bottoms are predominantly bedrock and gravel. Consideration was given to installing rubble jetties and low-head rock dams in the channels to enhance fishery habitat since present habitat is suitable for only minnows and small fish. The effectiveness of these measures is doubtful because of the bedrock and gravel in the channel bottoms and is not included in the plan.

The size, location and design features of floodwater retarding structures were influenced by the level of protection needed to meet project goals; flood plain area needing protection; and obstructions such as highways, county roads, farmsteads, and other developments. Seven locations for structures were studied. The five structures included in this plan were selected by the sponsors since this combination is the cheapest alternative, economically sound, engineeringly feasible and will provide a high level of protection.

This plan has been coordinated with the Tennessee Historical Commisssion. No historical or archeological values will be affected.

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WORKS OF IMPROVEMENT TO BE INSTALLED

The planned works of improvement to be installed are: (1) needed conservation measures on 2,450 acres of land; and (2) five floodwater retarding structures for flood prevention with modified principal spillway risers to preserve fishery habitat.

The kinds of measures, quantities, and distribution of installation costs (P. L. 566 funds and Other funds) for the total project are shown on Table 1.

Land Treatment Measures

The land treatment measures to be installed on about 2,450 acres of land will have a measurable physical effect on the watershed. These measures will improve the hydrologic condition, decrease runoff, erosion and sediment production, and assure the realization of benefits used in project justification. These planned land treatment measures will be installed at an estimated cost of $121,300.

Voluntary conservation planning is a prerequisite to successful application of a soil and water conservation program. Technical assistance will be provided to the farmers for planning and applying conservation practices and making land use adjustments. The adjustments, together with conservation and management practices, will be worked out with the individual farmers in harmony with the overall land use and water management plan for the watershed. The resulting Conservation Plans will be in accordance with needs for sustained productive land use on the individual farms.

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Alternative measures and land uses will be in keeping with standards used in obtaining effective soil and water conservation as outlined in the SCS Work Unit Technical Guide. Alternative land use and conservation measures that are necessary and justifiable for the conservation, development, protection, and improvement of the individual farms may be installed. Conservation measures on 850 acres of forest land will consist of tree planting, release, improvement cutting, and livestock exclusion.

The conservation measures planned on 200 acres of cropland will consist of suitable combinations of conservation cropping systems, contour farming, stripcropping, grassed waterways, and diversions on the upland and surface field ditches, diversions, row arrangements, and drainage mains and laterals on the flood plain.

The treatment of 1,310 acres of pastureland will consist of land use conversions and establishment on 50 acres of idle or cropland to perennial-type pasture and hayland; and renovation of 1,250 acres of pasture and hayland. Other alternative combinations of measures to achieve adequate treatment such as grassed waterways, pasture and hayland management, drainage or diversions will be used. About 25 farm ponds will be constructed on 10 acres to complement pasture management.

Also included in the land treatment program are measures planned to improve 90 acres of land for recreational use and wildlife habitat. A 50-acre area adjacent to floodwater retarding reservoir No. 2 will be improved by establishment or reestablishment of grasses, or grasses and legumes, shrubs, trees, or other plants in conjunction with grading and shaping the surface of the land to meet the requirements of facilities. Footpaths and other recreational facilities may be installed to complement and enhance existing developments.

About 40 acres will be improved by retaining, creating, or managing habitat for wildlife. The wildlife needs of food, cover, and water will be provided as a part of the adjustments in land use and land treatment program in the watershed. Individual landowners will be provided technical assistance in planning and carrying out practices that will enhance the supply of wildlife food and cover on the farms. A timber management program which favors forest land wildlife habitat will be encouraged and recommended. Wildlife habitat improvement will include the establishment of plantings for food and cover along field borders, streambanks, drainage ditches, fences, and other open areas.

About 76 percent of the watershed will be adequately treated by the end of the project installation period. This includes 3,441 acres presently treated and 2,450 acres planned in the Works of Improvement.

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Structural Measures

Planned works of improvement to be installed are five single-purpose floodwater retarding structures for flood prevention and modification of the risers of the principal spillways to preserve and replace fishery habitat. The total estimated installation cost of these measures is $1,830,500. These structures will control 3.58 inches or 1,437 acre-feet of runoff from 4,817 acres or 50 percent of the watershed's 9,650-acre drainage area.

The reservoir area behind each dam will accomodate the 100-year sediment accumulation. The principal spillways, consisting of a reinforced concrete riser and pipe, are designed as single-stage and have submersed inlets. All risers will be built to the elevation of the 100-year sediment accumulation. The riser modifications of structure numbers 1, 2, and 3 will allow use of about 88 acre-feet of storage for stream flow maintenance.

The earth embankment of the dams will be built primarily of clays, gravelly clays, gravelly clayey silts, and highly weathered calcareous limestone and siltstone materials. Principal spillways for the dams will consist of a reinforced concrete riser and pipe conduit with a metal slide headgate located near the bottom of the riser to facilitate lowering the water level for vector control and draining of the reservoir or fluctuating the level, as needed. The principal spillway will outlet into a stilling basin founded in rock with riprap placed on the sides of the basin. The dams are designed on class "c" criteria which sets the percent chance of use of the emergency spillways at 1 percent. Emergency spillways at all dams are designed as earth spillways; however, some rock excavation is anticipated at Sites No. 4 and 5.

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Limestone bedrock underlies structure numbers 1, 3, 4, and 5. Structure number 2 will be founded on shale. Treatment of the foundations at all of the sites will be necessary to assure the stability of the structures. Treatment will only be used to assure structural stability and no Federal funds will be expended to assure water retention in the sediment pools. To function as a floodwater retarding structure, it will not be necessary for the sediment pools to retain water. Some of the sites may not retain water in their sediment pool since there are potential foundation problems due to the geology of the area.

Dental grouting of exposed cracks and crevices in the bedrock will be accomplished as needed at the sites. Subsurface pressure grouting of solution channels in the foundation rock may be needed. The structure foundations will be thoroughly investigated prior to construction and test results will be carefully analyzed to determine the extent of subsurface grouting needed to insure structural stability of the dams. Installation of foundation drains and excavation of cutoff trenches to bedrock will be needed.

After careful study of the geologic findings in Red Boiling Springs Watershed and if adverse conditions are found, some of the dams will be designed with dry sediment pools.

The embankments, emergency spillways, and other areas within the easement area that are disturbed during construction will be stabilized with suitable vegetation. Emergency spillways founded in earth will be in erosion resistant soils and seeded with fescue. Other vegetative plantings will be established from fescue, sericea, or any other suitable vegetation by seeding, mulching, fertilizing, liming, and proper management. The seeding will be done in conjunction with shaping and preparation of an adequate seedbed. These plantings will be fenced as needed to protect from overgrazing and to insure proper maintenance.

Installation of the structural measures will require removing or modifying some fixed improvements within the easement areas. These are:

Site No. 1 - 2,400 feet of electric powerline and 3,000 feet of gravel road.
Site No. 2 - 1,600 feet of gravel road for property owners' access;
Site No. 3 - 500 feet of electric powerline; and
Site No. 5 - A farmstead, a vacant house, two barns, 2,640 feet of gravel road, and 3,000 feet of electric powerline.

Mitigating Measures

The principal spillway of the floodwater retarding structures will be modified to include a submersed inlet. This inlet will be an appurtenance to the principal spillway and will consist of a vented tube that extends from slightly above the surface of the sediment pool to a predetermined depth. This modification will take the normal base stream flow from below the surface of the sediment pool to avoid increasing the downstream water temperature.

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The principal spillways of structure numbers 1, 2, and 3 will be built to release water through an ungated port at the combined rate of about 0.2 cubic feet per second to maintain streamflow during the dry summer months. The inlet elevation for structure No. 1 will be 865.5, for structure No. 2 at elevation 821.5 and at elevation 867.5 for structure No. 3. There is adequate storage to support this flow for a period of about 6 months without recharge. These measures are planned to maintain the water quality and fish habitat in the streams below the dams as well as aiding the aesthetic value realized from a "babbling brook."

The total estimated cost to modify the risers of the principal spillways is included as an item of construction.

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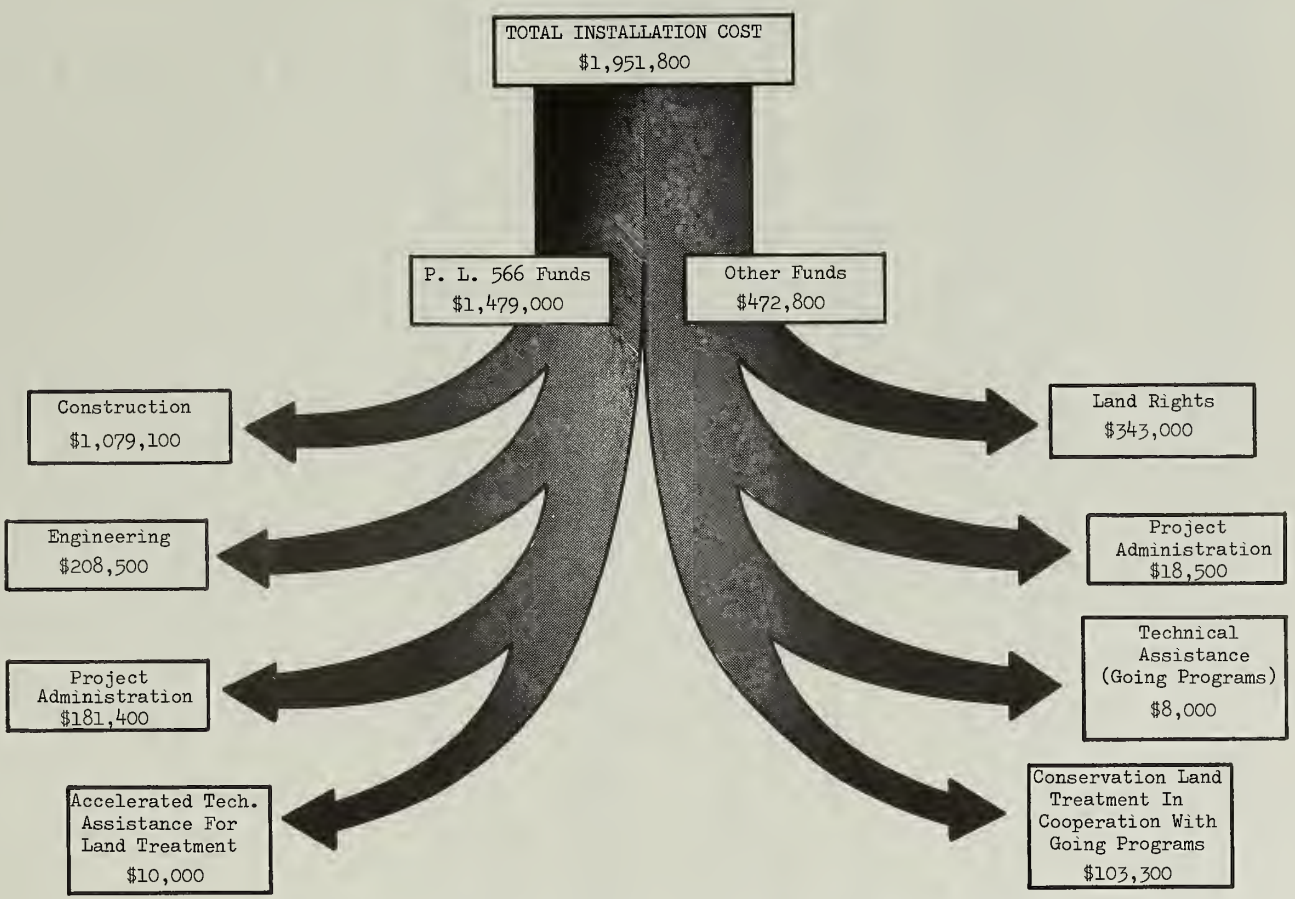
EXPLANATION OF INSTALLATION COSTS

The total estimated installation cost of the project is $1,951,800, of which $1,479,000, or about 76 percent, will be P. L. 566 funds, and $472,800, or about 24 percent, will be Other funds. The following chart illustrates the distribution of cost as outlined in Table 1.



These estimates represent all of the direct and indirect cost items to install the project measures such as labor, materials machinery, etc.

Land Treatment Measures

The land treatment measures have an estimated installation cost of $121,300--Public Law 566 funds will furnish $10,000 and Other funds will furnish $111,300.

The Soil Conservation Service will provide technical assistance for the preparation and application of conservation plans. Accelerated technical assistance in the amount of $10,000 will be provided from P. L. 566 funds and $5,600 from going soil conservation district programs.

The estimated costs of forestry land treatment measures are $8,400 and will be borne by landowners, REAP, and other cost-sharing programs. The estimated cost of fire control measures is $3,000. Technical assistance costs to be borne by the Division of Forestry, Tennessee Department of Conservation, are estimated to be $2,400.

Financial assistance will be used as available through the Rural Environmental Assistance Program or other going programs.

The goals for land treatment measures were based on field surveys and were adjusted to meet expected landowner participation. Installation costs were based on prices paid by landowners.

Technical assistance costs are based on the present cost of the going Soil Conservation Service Program. Soil surveys have been completed under regular district and RC&D assistance.

Structural Measures

The estimated installation cost of the five single-purpose floodwater retarding structures for flood prevention is $1,830,500. The cost to be borne by P. L. 566 funds for construction and engineering services is $1,287,600. The estimated construction cost of $1,079,100 includes $10,000 for modified principal spillways, $235,000 foundation treatment, and $115,600 for contingencies. Estimated cost for engineering services is $208,500, which includes the direct cost of engineers and other technicians for surveys, investigations, design, and preparation of plans and specifications for structural measures including the vegetation. The cost of engineering services does not include similar services for land rights. The installation cost to be borne by Other funds is estimated to be $343,000 for land rights. The acquisition of land rights needed to construct the dams will not require the displacement of any person, business, or farm operation as described in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970. Included in the land rights costs are $61,800 for the removal, modification, or alteration of two barns, two houses, 5,900 feet of electric powerline, and 7,240 feet of gravel road.

The total estimated cost for project administration is $199,900, of which $181,400 will be P. L. 566 funds and $18,500 will be Other funds. Project administration costs are those costs associated with administering the installation of structural measures. P. L. 566 funds will be used for

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reviewing engineering plans and for providing inspectors to insure that structural measures are installed in accordance with plans and specifications.

Other funds will be used to provide for contract administration, legal fees, land acquisitions, and other general administration costs of the sponsors. The local sponsoring organizations will provide without P. L. 566 cost-sharing, the engineering, legal, and administrative costs incurred for acquiring land rights.

The following is an estimated schedule of funds for a 4-year project installation period and covers land treatment and structural measures. The schedule may be adjusted from year to year on the basis of any significant need and with consideration given to the project measures completed and appropriations actually made available by the Federal Government.

SCHEDULE OF ESTIMATED INSTALLATION COSTS
Red Boiling Springs Watershed, Tennessee

Project Year	Estimated Cost (Dollars)				Total
	Land Treatment		Structural Measures		
	Non-Federal Land		Non-Federal Land		
	P. L. 566 Funds	Other Funds	P. L. 566 Funds	Other Funds	
First	5,000	22,300	123,800	120,000	271,100
Second	5,000	33,400	530,200	31,500	600,100
Third	0	33,400	254,400	205,000	492,800
Fourth	0	22,200	560,600	5,000	587,800
TOTAL	10,000	111,300	1,469,000	361,500	1,951,800

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EFFECTS OF WORKS OF IMPROVEMENT

The proposed works of improvement in the Red Boiling Springs Watershed constitute a needed and harmonious element in the overall economic development program for Clay and Macon Counties and the Appalachian Region. Economic benefits resulting from the project will have a socio-economic impact on the community and surrounding area by improving, conserving, and utilizing the available natural and human resources. The project measures will directly benefit about 2,920 acres in the watershed consisting of 470 acres of flood plain land and 2,450 acres of upland.

The conservation land treatment measures will reduce runoff and erosion, increase vegetative cover, improve the scenic quality of the landscape, and provide food and cover for wildlife in many scattered locations throughout the watershed area.

The combination of land treatment and structural measures will reduce flood damage to crops and pasture by about 49 percent, other agricultural damage by 59 percent, road and bridge damage by 93 percent, damage to urban property in Red Boiling Springs by 97 percent, and damage from overbank deposition of sediment and flood plain scour by 60 percent and 70 percent respectively. Indirect damages from flooding will be reduced about 96 percent.

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The project will benefit thousands of people including those who live, seek employment, or trade within the watershed, as well as tourists and the traveling public. It is estimated that 2,000 citizens now occupying or utilizing some 125 farms and about 150 parcels of industrial, commercial, and residential property will be directly benefited.

After the project is installed, damage sustained by homes, commercial, and public properties in the flood plain of Salt Lick Creek and Haney Branch will essentially be eliminated from a 100-year frequency flood. The low-lying area along the creeks will still flood as indicated on the urban flood plain map of Red Boiling Springs (page 77).

The majority of the fixed improvements in the extreme low-lying area of the flood plain have already been removed or will be removed during installation of the open space sidewalks and park project. The depth of flooding will be below the floor elevation of the remaining buildings. There will be no apparent risk of loss of life and flooding from the 100-year flooding event will be limited to such property as yards, streets, gardens, parking lots, and agricultural areas. Proper land use in the flood plain will be carried out by zoning in the low-lying area. Flood proofing of remaining structures and periodic announcements of the flood hazard in this area will help minimize any future flood damage.

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The following table shows the future expected conditions of peak flows after the project is installed. This table can be compared with the "without project" conditions on page 29 to indicate the effect of the project.

Frequency (Years)	Date of Historical Flood	Amount of Flow (CFS)	Depth of Water Over Low Point in Valley 1/	Damage	Flood Damage Reduction Benefits ($)
500	June 1969	6,900	4.4	280,000	607,000
100	No Occurrence	3,400	2.2	2,000	585,000
25	January 1946	2,700	1.8	1,600	398,400
10	February 1962	2,100	1.0	1,000	219,000

1/ Reference for the low point in valley is north of the U. S. Post Office or Valley Section No. 37 shown on the project map.

A flood similar to the June 1969 occurrence would be reduced 3.6 feet by the project at Valley Section No. 37 shown on the project map (last page in this plan). Since a higher degree of protection is not economically feasible due to structure site limitations, the sponsors plan to prevent to the extent possible, development (both new and reconstruction) in the area subject to flooding by the 100-year flood event.

The agricultural areas in the flood plain will be protected from the one year frequency flood below Red Boiling Springs and a much higher level of protection will be provided to agricultural areas above town. This will allow landowners to produce crops without the constant threat of flood damage. Land values in the flood plain after the project is installed are estimated to range from $500 to $2,000 per acre.

The proposed conservation measures and improvement of natural resources on about 2,450 acres is in the public and private interest. All land in the watershed is eligible for assistance under the going and accelerated conservation program. The objective of farmers, especially those of low income, is to improve their socio-economic position by developing a long-range plan that will result in the highest net family income. The plan would be based on production alternatives that will provide the most productive use of land, labor, capital and management.

The conservation measures will provide more adequate cover, improve infiltration and physical conditions of the soil, improve runoff characteristics of the soil, reduce erosion and sediment production and increase income potential.

Forest land has already created a beneficial cover which reduces the effects of runoff, erosion, sediment problems arising on agricultural and urban lands. In addition, the forests are effectively providing recreation, wildlife and aesthetic values for the watershed. As management becomes more and more effective and widespread, the forests will contribute even more significantly to the aesthetic and environmental aspects of tourism and rural living in the watershed.

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The protection afforded by the project will permit land use adjustments of the flood plain and upland. Estimates indicate that there will be no increase in the total acreages of allotted crops within the watershed. Future land use is estimated to be:

Land Use	Acres	Percent
Cropland	475	5
Pastureland	4,000	41
Forest Land	3,350	35
Miscellaneous	710	7
Red Boiling Springs	1,115	12
TOTAL	9,650	100

The five floodwater retarding structures have a combined drainage area of 4,817 acres or approximately 50 percent of the total watershed area. Runoff from 70 percent of the drainage area above the city of Red Boiling Springs will be controlled. The structures will effectively trap inflowing sediment which would otherwise be available for transport downstream. This will greatly reduce sediment pollution of the stream which is ordinarily produced by storm runoff. Besides providing protection to the downstream fishery habitat it will help preserve the asthetic value of this crystal clear, spring-fed stream. Submersed inlets on the principal spillway risers will maintain the present temperature of the base flow in the streams below the structures. Additional riser modifications at structure numbers 1, 2, and 3 will allow release of water from the pools for maintaining stream flow.

Flood protection provided by the project will allow for the orderly growth and continued development of Red Boiling Springs. The health and welfare of the citizens will be greatly enhanced. Private expenditures for repair of damages and replacement of losses can be used to increase standards of living. Public expenditures can be used to increase services. The project will protect tourist facilities and historic values and enhance the unique aesthetic values in the area.

The project will allow for the expansion of existing industries and the attraction of new industries to the immediate area in and around the city of Red Boiling Springs. The watershed project will help sustain the present 900 jobs and will create 160 more jobs.

Studies by the City Planning Board indicate that with flood protection existing industries will install new equipment, expand output, and create many new jobs. New industries in the field of arts and mountain crafts are expected to locate in the watershed. As new jobs are created the population will increase. The work force now migrating to other sections of the country in search of employment will be employed in local jobs. With flood protection to the hotels, mineral springs and the scenic valley in and around Red Boiling Springs, tourist trade is expected to flourish.

Reduction in the flood hazard will permit farmers to use improved management and technology. The protection afforded will stimulate farmers to

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increase management inputs, fertilize more efficiently, establish more effective on-farm drainage systems, use improved varieties of seed, and use a more effective insect control program. Farm income will be enhanced due to decreased unit cost of production and increased mechanization and efficiency in farming operations.

Local secondary benefits will accrue in the watershed and surrounding area due to the installation of the project. Goods and services produced as a result of the project will tend to stimulate local economic activity on a permanent basis. Products produced will require additional services from within the area and create additional employment opportunities.

Benefits will also accrue due to the financial and technical assistance made available by the installation of the project. Outside resources will be brought into the area and will provide an opportunity to use goods, services, and labor available in the local community. Maintenance of the proposed works of improvement will provide continued opportunities for employment after the project is installed.

The project will enhance the efforts of the community in promoting or attracting tourists. A presently planned Open Space Program consisting of a 10-acre strip park and sidewalks along Salt Lick Creek for tourist attraction and beautification will be provided flood protection.

The floodwater-retarding structures have the potential for impounding 55 surface acres of water. Water impounded in the sediment pool areas can provide habitat for lake fishery, provide watering sites for wildlife and resting area for migratory waterfowl. Agricultural use of the sediment pool areas will be permanently lost as will the wildlife habitat provided by the 11 acres of cropland, 20 acres of pastureland, and 24 acres of forest land. About 1.8 miles of stream channels having little or no fishery value will also be inundated.

Use of the 78 acres in the flood pool areas of the structures by wildlife and for agricultural purposes will be periodically interrupted by temporary flooding. This area includes 15 acres of cropland, 24 acres of pastureland, and 39 acres of forest land.

About 107 acres of land will be needed for construction of the dams and spillways, excavation of borrow materials and other work areas. This will involve about 12 acres of cropland, 48 acres of pastureland, and 47 acres of forest land. The dams and spillways will occupy about 22 acres of this area. All areas disturbed during construction will be stabilized with suitable vegetation. These plantings will be fenced as needed to protect from overgrazing and to insure proper maintenance. Agricultural use of the area will be lost with the exception of controlled grazing, and use of the area by wildlife will be temporarily lost during construction.

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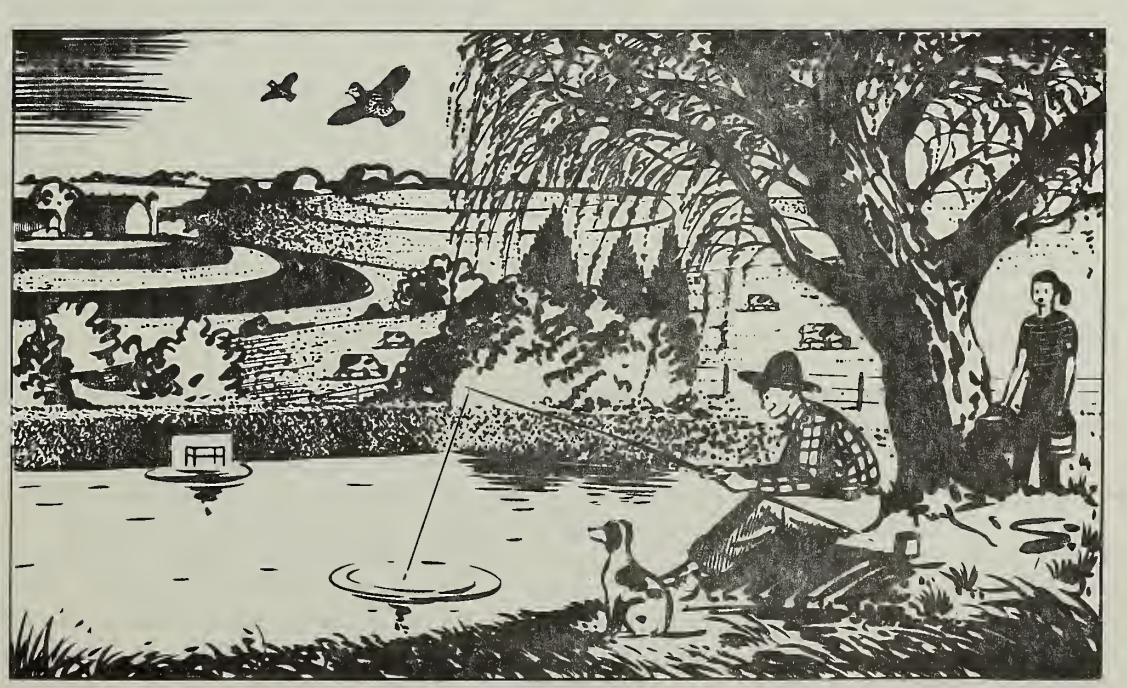
The benefits to be derived from environmental improvements are highly variable and less tangible and more difficult to measure quantitatively than the physical damages. The project will preserve, enhance, or create environmental conditions that are in harmony with national goals for improvement of the resources of air, water, and land. The following factors will contribute to an environmental balance:

a. Reduce runoff, erosion and sediment production.
b. Reduce flood damage to crops and pasture by 49 percent.
c. Reduce other agricultural food damage by 59 percent.
d. Reduce flood damage to roads, bridges and streets by 93 percent.
e. Reduce flood damage to residential, commercial, industrial and public property by 97 percent.
f. Reduce sediment damage to flood plain land by 60 percent.
g. Reduce flood plain scour damage by 70 percent.
h. Reduce indirect damage from flooding by 96 percent.
i. Essentially eliminate the risk of loss of life from flooding.
j. Help stimulate economic activity on a permanent basis by sustaining the present 900 jobs.
k. Increase employment opportunities in the Red Boiling Springs area through commercial and industrial development by creating 160 new jobs.
l. Essentially eliminate health hazards resulting from flooding.
m. Protect historic values from flood damage.
n. Enhance the unique aesthetic values in the area.
o. Create the potential for 55 surface acres of additional water that can be used for lake fishery, wildlife watering and waterfowl resting area.



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PROJECT BENEFITS

The average annual benefits used in justification of the project structural measures are estimated to be $169,090, Table 6.

The average annual flood damage without the project is estimated to be $162,630, and the estimated benefits from flood damage reduction are $154,930, Table 5. These benefits consist of reduction in damages as follows: crop and pasture, $1,640; other agricultural, $130; road and bridge, $6,380; residential, commercial, public and industrial property in Red Boiling Springs, $102,890; sediment, $1,040; erosion, $120; and indirect, $42,730.

Redevelopment benefits as a result of the employment of the local labor force with insufficient resources to keep them fully employed were evaluated. Employment of the skilled and semiskilled laborers and part-time farmers will induce economic development within the area. Economic development benefits from increased employment of local labor amount to $18,600 annually. Outside resources will be brought into the area and will provide an opportunity to use goods, services, and labor available in this rural resort community. The installation of project measures will create at least 160 new jobs and help sustain the present 900 jobs.

The value of increased demands for goods and services as a result of economic activities stemming from and induced by project installation were evaluated as a secondary effect. The value of local secondary benefits are estimated to be $10,160 annually. Local secondary benefits will accrue from increased expenditures by the people directly benefited. Expenditures for consumer items will provide added profits to those who supply the goods and services. A multiplier effect or a chain reaction will occur and will have a tendency to stimulate the local economy on a more permanent basis.

The value of secondary benefits from a national viewpoint was not considered pertinent in the economic evaluation or justification of this project.

Research and experience have demonstrated that the combined private and public benefits derived from land treatment measures will exceed their cost of installation. Estimates indicate that annual benefits of $36,100 will accrue as a result of the application of conservation treatment measures. Flood damage reduction benefits are estimated to be $14,600 and conservation benefits are $21,500. The land treatment measures to be installed will increase income and meet the needs, desires, and objectives of the individuals; but the treatment measures will vary with land use, economic conditions, acreage controls, customs, trends, conservation needs and flood reduction.

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COMPARISON OF BENEFITS AND COSTS

The estimated average annual cost to install, operate and maintain the five floodwater retarding structures in this plan is $106,705. The project will yield at least $169,090 average annual benefits which include local secondary benefits of $10,160 that will accrue within the zone of influence of the project.

The benefit-cost ratio accruing as a result of total project benefits is 1.6 to 1.0, and the benefit-cost ratio without secondary benefits is 1.5 to 1.0. Benefits and costs are compared in Table 6, page 68.

PROJECT INSTALLATION

The sponsors of the Red Boiling Springs Watershed project plan to install the land treatment and structural measures during a 4-year period. The dams will be built as a construction unit during the last three project years. The actual sequence of construction will depend on: (1) agreements from not less than 50 percent of the owners and operators to carry out recommended soil and water conservation measures; and (2) order of obtaining land rights. The anticipated plan for installation of project works of improvement is:

Project Year	Item
1	(1) Install 20 percent of accelerated land treatment. (2) Field survey work for structure numbers 1, 2, and 3. (3) Prepare designs & acquire land rights for structure numbers 1, 2, and 3.
2	(1) Install 30 percent of accelerated land treatment. (2) Prepare design & acquire land rights for structure number 4. (3) Field survey work for structure number 4. (4) Build structure numbers 1, 2, and 3.
3	(1) Install 30 percent of accelerated land treatment. (2) Build structure number 4. (3) Prepare design & acquire land rights for structure number 5. (4) Field survey work for structure number 5.
4	(1) Install 20 percent of accelerated land treatment. (2) Build structure number 5. (3) Final inspection of project measures and close project.

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Members of the Red Boiling Springs City Council review the location of the five proposed flood prevention dams.

The City Council has named the five floodwater retarding structures as follows:

Site No. 1 - Edmund Jennings Lake
Site No. 2 - Katawley Lake
Site No. 3 - Shepherd Kirby Lake
Site No. 4 - Jennifer-Renah Bilbrey Lake
Site No. 5 - Willis Knight Lake

The city of Red Boiling Springs has legal authority to raise funds and the power of eminent domain to acquire all land rights needed for the installation of the structural measures for flood prevention. The city will obtain all land rights and will be responsible for all costs incurred in acquiring the needed land rights for the orderly installation of the planned structural works of improvement. If necessary, the city will use its power of eminent domain. The city will be responsible for the costs of engineering and legal services involved in land rights acquisition.

Conservation treatment measures will be voluntarily planned and applied by the landowners in cooperation with the going and accelerated program of the Macon and Clay County Soil Conservation Districts. The Soil Conservation Service will provide technical assistance for the preparation and application of conservation plans and will accelerate the technical assistance to the going district programs from P. L. 566 funds.

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The Macon and Clay County Soil Conservation Districts will obtain agreements from farmowners and operators to carry out conservation farm plans on not less than 50 percent of the land in the drainage area above the floodwater retarding structures. These agreements will be obtained prior to P. L. 566 funds being provided for construction of the works of improvement.

The U. S. Forest Service, by and through the Tennessee Division of Forestry, is already providing the technical assistance necessary to achieve timely forest management under the going Cooperative Forest Management Program and the Cooperative Forest Fire Control Program. No difficulty is foreseen in keeping pace with the growing interest in environmental forest management.

The Soil Conservation Service will provide engineering and technical assistance to the sponsors for design, preparation of specifications, inspection of construction, preparation of contract payment estimates, final inspection, execution of certificates of completion, and related tasks for the establishment of all planned single-purpose works of improvement for flood prevention.

The sponsors will comply with the provisions contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) and the regulations issued by the Secretary of Agriculture pursuant thereto.

The city will assume the responsibility for administering contracts; however, they may at a later date request the Soil Conservation Service to administer the contracts.

Roads, houses, barns, and utility lines involved in the floodwater retarding structure sites will be altered, modified, or relocated as agreed upon by the sponsoring local organizations, the local branch of government responsibile for roads, and the Service. The sponsoring local organizations will be responsible for the disposition of these facilities and other land rights matters.

The sediment pools of the floodwater retarding structures can be correctly stocked with fish. These fish can be obtained from Federal, State or private hatcheries. Technical assistance will be provided by the Soil Conservation Service in stocking and managing these pools for fish production. The dams will be constructed to meet the requirements and regulations of the Tennessee Department of Public Health.

Contractors will be required to adhere to strict guidelines for minimizing soil erosion and water and air pollution during construction.

Safety and health regulations will be carried out by contractors for the protection of the general public. Shoreline conditioning of the pool areas at all of the structure sites will be required as needed to conform with state regulations for vector control. Timber cleared from construction sites will be salvaged for commercial use or disposed of by other means so it will not create unsatisfactory levels of air or water pollution.

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The watershed work plan has been coordinated with the Tennessee Historical Commission. Investigations by the Commission indicate that installation of the project will not encroach on any known archeological values, any historic place, or any planning by the Commission for historic preservation. In the spring of 1970, the Commission erected a marker recognizing the historical value of the old resort facilities in Red Boiling Springs, many of which are subject to damage from flooding. The National Park Service and other interested Federal, State, and local agencies will be kept current on progress of the project. These agencies will be notified if artifacts or other items of archeological or historical significance are uncovered during construction so evaluation and salvage operations can be carried out.

FINANCING PROJECT INSTALLATION

Since Red Boiling Springs is in the Hull-York RC and D project area, the city is eligible for a loan from Farmers Home Administration to finance its share of the watershed project and the open space project. The city has, in fact, obtained a loan of $150,000 from FHA and is now acquiring land for both projects.

A sales tax added to this customers purchase will add about 2 cents to her cost, but the revenue will repay a Farmers Home Administration loan that the city will use to pay the local share of the project.

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The city of Red Boiling Springs will meet its financial challenge from a ½-cent sales tax approved by referendum by its residents on September 19, 1970. The sales tax is presently yielding sufficient income to retire the $150,000 loan in about 27 years. An improved economic condition in the community will retire the loan earlier than 27 years.

Since State and Federal laws prohibit the city from using the sales tax as collateral for the FHA loan, the residents of the town approved by referendum for the city council to pledge property tax as collateral for bonds purchased by FHA for the $150,000 loan. Although the revenue from property tax is not expected to be needed for the FHA loan, it is extra financial assurance that the city can meet its financial obligation.

Another source of money for the city is a $25,000 gift from Macon County Quarterly Court to be used for land rights for the watershed project.

Loans from banks are also being used by the city so they can move ahead in acquiring land rights. The city now has all land rights for structure number 1 and is negotiating with owners on other sites.

The city has analyzed its financial needs in consideration of the scheduled installation of the works of improvement and feels confident that adequate arrangements have been made to finance the local share of the project.

Funds needed to adequately protect, operate and maintain structural measures will be provided by the city from regular sources of revenue.

The land treatment measures will be voluntarily installed by the landowners and operators at their own expense. Cost-sharing assistance now available under the Rural Environmental Assistance Program or other going program will be utilized in applying these measures.

Federal assistance for carrying out the works of improvement on non-Federal land, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended. This assistance is contingent on the appropriation of funds for this purpose and the sponsoring local organizations meeting their necessary prior obligations.

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PROVISIONS FOR OPERATION AND MAINTENANCE

Landowners will be responsible for the maintenance of land treatment measures installed on their farms under agreement with either the Macon or Clay County Soil Conservation District.

The landowners and operators will provide the maintenance for forest land improved during the program period. The Tennessee Division of Forestry, in cooperation with the U. S. Forest Service, will furnish the technical assistance needed to operate and maintain these forest lands under the going Cooperative Forest Management Program. The Division will continue to furnish forest fire protection under the Cooperative Forest Fire Control Program.

The city of Red Boiling Springs will be responsible for adequately protecting, operating, and maintaining the floodwater retarding structures and is estimated to cost $3,300 annually. The city plans to arrange with the landowners and operators for minor maintenance jobs to be done as part of regular farm operations and is estimated to cost $2,300 annually. The major maintenance jobs, estimated to cost $1,000 annually, will be accomplished by the city of Red Boiling Springs since this may require skilled labor or machinery normally not found on a farm.

Maintenance of the floodwater retarding structures includes performance of work and the application of measures to prevent deterioration as well as repairing damages that may occur. The cost can usually be minimized by performing maintenance when it is first needed. Maintenance of the structures will include, but may not necessarily be limited to, removal of debris from principal spillways, repair of fencing, keeping adequate vegetation on the dam and emergency spillway, restoring concrete that has deteriorated, restoring protective coatings to gates, valves, and metal, and other repair of damage that may result from a flood event or vandalism. The floodwater retarding structures will be maintained in accordance with regulations of the Tennessee State Department of Public Health.

The Service and the sponsors will make a joint inspection annually, or after unusually severe floods, for 3 years following installation of each structural measure. Inspection after the third year will be made annually by the sponsors and a report prepared by them with a copy to the Service representative.

The city of Red Boiling Springs and the Service will execute specific operation and maintenance agreements prior to the issuance of invitations to bid on construction of any structural measures for flood prevention.

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Red Boiling Springs Watershed, Tennessee

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		
		Non-Fed Land	P. L. 566 Funds	Other Funds	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	200	0	5,800	5,800
Pastureland	Acre	1,400	0	86,100	86,100
Technical Assistance	xxxx		10,000	5,600	15,600
SCS - Subtotal	Acre	1,600	10,000	97,500	107,500
Forest Service					
Forest Land	Acre	850	0	8,400	8,400
Cooperative Forest Fire Control	Acre	(3,400)	0	3,000	3,000
Technical Assistance	xxxx		0	2,400	2,400
FS - Subtotal		850	0	13,800	13,800
TOTAL - LAND TREATMENT		2,450	10,000	111,300	121,300
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Floodwater Retarding Strs.	No.	5	1,079,100	0	1,079,100
SCS - Subtotal			1,079,100	0	1,079,100
Subtotal - Construction			1,079,100	0	1,079,100
Engineering Services					
Soil Conservation Service	xxxx		208,500	0	208,500
Subtotal - Engineering			208,500	0	208,500
Project Administration					
Soil Conservation Service					
Construction Inspection	xxxx		83,400	0	83,400
Other	xxxx		98,000	18,500	116,500
Subtotal - Administration			181,400	18,500	199,900
Other Costs					
Land Rights	xxxx		0	343,000	343,000
Subtotal - Other			0	343,000	343,000
TOTAL STRUCTURAL MEASURES			1,469,000	361,500	1,830,500
TOTAL PROJECT			1,479,000	472,800	1,951,800
SUMMARY					
Subtotal SCS			1,479,000	459,000	1,938,000
Subtotal FS			0	13,800	13,800
TOTAL PROJECT			1,479,000	472,800	1,951,800

1/ Price base - 1970.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
Red Boiling Springs Watershed, Tennessee

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping Systems	Acre	125	1,500
Contour Farming	Acre	118	500
Cover and Green Manure Crops	Acre	109	2,700
Diversions	Feet	8,548	2,200
Grasses and Legumes in Rotation	Acre	110	1,700
Grassed Waterways	Acre	16	1,600
Drainage Mains and Laterals	Acre	2,000	500
Terraces, Gradient	Feet	2,660	300
Farm Ponds	No.	46	11,500
Pasture and Hayland Management	Acre	1,721	10,300
Pasture and Hayland Renovation	Acre	52	3,100
Pasture and Hayland Planting	Acre	2,071	124,200
Tree Planting	Acre	120	1,200
Critical Area Planting	Acre	4	500
Wildlife Habitat Development	Acre	4	100
TOTAL - LAND TREATMENT	xxxx	xxxx	161,900

1/ Price base - 1970.

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Red Boiling Springs Watershed, Tennessee
(Dollars) 1/

Item	Installation Cost - P. L. 566 Funds			Installation Cost - Other Funds		Total Installation Cost
	Construction	Engineering	Total P. L. 566	Land Rights	Total Other	
Floodwater Retarding Structures:						
1	176,100	39,300	215,400	49,000 2/	49,000	264,400
2	152,900	34,100	187,000	32,000 3/	32,000	219,000
3	130,100	29,000	159,100	32,000 4/	32,000	191,100
4	139,400	31,100	170,500	30,000	30,000	200,500
5	480,600	75,000	555,600	200,000 5/	200,000	755,600
Subtotal - Floodwater Retarding Structures	1,079,100	208,500	1,287,600	343,000	343,000	1,630,600
Project Administration	xxxx	xxxx	181,400	xxxx	18,500	199,900
GRAND TOTAL	1,079,100	208,500	1,469,000	343,000	361,500	1,830,500

1/ Price base - 1970.
2/ Incl. $10,500 for relocation or modification of 2,400 ft. of powerlines and 3,000 ft. of gravel roads.
3/ Incl. $2,000 for relocation or modification of 1,600 ft. of gravel road.
4/ Incl. $500 for relocation or modification of 500 ft. of powerlines.
5/ Incl. $10,000 for relocation or modification of 2,640 ft. of gravel road; $12,000 for the purchase of two houses; $23,800 for the purchase of two barns and 7 acres of land; and $3,000 for relocation or modification of 3,000 ft. of powerlines.

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TABLE 3 - STRUCTURAL DATA
STRUCTURES WITH PLANNED STORAGE CAPACITY
Red Boiling Springs Watershed, Tennessee

ITEM	UNIT	Structure Numbers		
		1	2	3
Class of Structure		c	c	c
Drainage Area	Sq.Mi.	o.62	0.71	0.66
Curve No. (1-day)(AMC II)		76	76	75
Tc	Hrs.	0.47	0.74	0.50
Elevation Top of Dam	Ft.	893.5	845.6	893.3
Elevation Crest Emer. Spwy.	Ft.	883.2	836.5	883.8
Elevation Crest High Stage Inlet	Ft.	871.5	826.0	873.0
Elev. Crest Low Stage Inlet	Ft.	-	-	-
Maximum Height of Dam	Ft.	47	38	42
Volume of Fill	Cu.Yds.	88,600	73,900	65,700
Total Capacity	Ac.Ft.	158	171	160
Sediment Submerged (100-Yr.)	Ac.Ft.	54	51	52
Sediment Aerated	Ac.Ft.	9	8	8
Retarding	Ac.Ft.	95	112	100
Between High & Low Stages	Ac.Ft.	-	-	-
Surface Area				
Sediment Pool	Acres	6	8	7
Retarding Pool	Acres	11	15	13
Principal Spillway				
Rainfall Vol. (areal)(1-day)	In.	6.62	6.62	6.62
Rainfall Vol. (areal)(10-day)	In.	11.70	11.70	11.70
Runoff Volume (10-day)	In.	6.31	6.31	6.00
Capacity of Low Stage (Max.)	cfs	-	-	-
Capacity of High Stage (Max.)	cfs	105	96	99
Freq. Operation - Emer. Spillway	% Chance	1	1	1
Size of Conduit	Dim	30	30	30
Emergency Spillway				
Rainfall Vol. (ESH)(areal)	In.	11.00	11.00	11.00
Runoff Volume (ESH)	In.	7.94	7.94	7.82
Type		Veg	Veg	Veg
Bottom Width	Ft.	50	60	60
Velocity of Flow (V_e)	Ft./Sec.	8.14	6.98	7.44
Slope of Exit Channel	Ft./Ft.	0.0265	0.0275	0.0281
Max. Water Surface Elevation	Ft.	886.2	839.2	886.3
Freeboard				
Rainfall Vol. (FH)(areal)	In.	28.30	28.30	28.30
Runoff Volume (FH)	In.	24.82	24.82	24.65
Max. Water Surface Elevation	Ft.	893.5	845.6	893.3
Capacity Equivalents				
Sediment Volume	In.	1.86	1.58	1.68
Retarding Volume	In.	2.86	2.94	2.82

(Continued)

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TABLE 3 - STRUCTURAL DATA (Cont.)
STRUCTURES WITH PLANNED STORAGE CAPACITY
Red Boiling Springs Watershed, Tennessee

ITEM	UNIT	Structure Numbers 4	5	Total
Class of Structure		c	c	
Drainage Area	Sq.Mi.	1.24	4.42	7.65
Curve No. (1-day) (AMC II)		73	75	-
Tc	Hrs.	0.69	1.02	-
Elevation Top of Dam	Ft.	870.4	852.6	-
Elevation Crest Emer. Spillway	Ft.	859.7	841.1	-
Elevation Crest High Stage Inlet	Ft.	844.7	820.2	-
Elevation Crest Low Stage Inlet	Ft.	-	-	-
Max. Height of Dam	Ft.	44	49	-
Volume of Fill	Cu.Yds.	70,900	294,700	593,800
Total Capacity	Ac.Ft.	274	1,174	1,937
Sediment Submerged (100-Yr.)	Ac.Ft.	59	239	455
Sediment Aerated	Ac.Ft.	10	39	74
Retarding	Ac.Ft.	205	925	1,437
Between High & Low Stages	Ac.Ft.	-	-	-
Surface Area				
Sediment Pool	Acres	9	25	55
Retarding Pool	Acres	20	74	133
Principal Spillway				
Rainfall Volume (areal) (1-day)	In.	6.62	6.62	-
Rainfall Volume (areal) (10-day)	In.	11.70	11.70	-
Runoff Volume (10-day)	In.	5.70	6.00	-
Capacity of Low Stage (Max.)	cfs	-	-	-
Capacity of High Stage (Max.)	cfs	105	172	-
Freq. Operation - Emergency Spillway	% Chance	1	1	-
Size of Conduit	Dim.	30	36	-
Emergency Spillway				
Rainfall Volume (ESH) (areal)	In.	11.00	11.00	-
Runoff Volume (ESH)	In.	7.54	7.82	-
Type		Rock	Rock	-
Bottom Width	Ft.	80	200	-
Velocity of Flow (V_e)	Ft./Sec.	8.23	8.51	-
Slope of Exit Channel	Ft./Ft.	0.0263	0.0255	-
Max. Water Surface Elevation	Ft.	862.8	844.4	-
Freeboard				
Rainfall Volume (FH) (areal)	In.	28.30	28.30	-
Runoff Volume (FH)	In.	24.29	24.36	-
Max. Water Surface Elevation	Ft.	870.4	852.6	-
Capacity Equivalents				
Sediment Volume	In.	1.06	1.21	-
Retarding Volume	In.	3.09	4.04	-

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TABLE 4 - ANNUAL COST
Red Boiling Springs Watershed, Tennessee
(Dollars) 1/

	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures	92,113	3,300	95,413
Project Administration	11,292	:::::	11,292
GRAND TOTAL	103,405	3,300	106,705

1/ Price base: Installation 1970; O&M Adjusted Normalized.
2/ 100 years @ 5-3/8 percent interest.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Red Boiling Springs Watershed, Tennessee
(Dollars) 1/

Item	ESTIMATED AVERAGE ANNUAL DAMAGE		Damage Reduction Benefits
	Without Project	With Project	
FLOODWATER			
Crop and Pasture	3,330	1,690	1,640
Other Agricultural	220	90	130
Non-Agricultural			
Road and Bridge	6,840	460	6,380
Residential, Commercial and Industrial Property	106,020	3,130	102,890
Subtotal	116,410	5,370	111,040
SEDIMENT	1,720	680	1,040
EROSION	170	50	120
INDIRECT	44,330	1,600	42,730
TOTAL	162,630	7,700	154,930

1/ Price base - Adjusted Normalized.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Red Boiling Springs Watershed, Tennessee
(Dollars)

Evaluation Unit	Average Annual Benefits 1/				Average Annual Cost 3/	Benefit-Cost Ratio
	Damage Reduction	Re-Development	Secondary	Total		
Floodwater Retarding Structures	140,330 2/	18,600	10,160	169,090	95,413	1.8:1.0
Project Administration	xxxx	xxxx	xxxx	xxxx	11,292	xxxx
GRAND TOTAL	140,330	18,600	10,160	169,090	106,705	1.6:1.0

1/ Price base - Adjusted Normalized.
2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $14,600 annually.
3/ From Table 4.

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INVESTIGATIONS AND ANALYSES

Land Treatment Data

The Conservation Needs Inventory for Clay and Macon Counties recently completed by the United States Department of Agriculture, under the leadership of the Soil Conservation Service, provided information on soil capability units by land use. Information was also obtained from the district conservationist and soil scientist concerning soils, capability units, and land use in the watershed. The conservation needs for the watershed were developed using this information and the Work Unit Technical Guide.

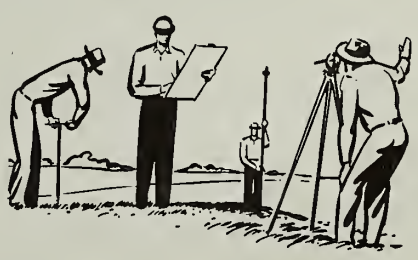
The conservation practices established to date, both quantity and value, were determined from field inspections and interviews with farm operators and from work unit records. This information was utilized in preparing Table 1A.

A systematic field survey showed ground cover, forest and hydrologic conditions, and treatment needs. This survey, supporting data, and information from other agencies and forestry officials, determined the amount of remedial measures. The measures recommended contribute to flood reduction and soil stabilization.

Conservation measures to be applied during the installation period were determined after considering the following factors: (1) future land use; (2) the availability of personnel for providing technical assistance and planning at the work unit office; (3) funds available from the Agricultural Stabilization and Conservation Service Office for cost-sharing; (4) interviews with operators in the watershed regarding the resource available for installing the needed land treatment measures; and (5) experience gained from the installation of similar projects.

Engineering Surveys

The first phase of the engineering surveys consisted of establishing about 10 miles of vertical control in feet with an elevation tolerance of 0.10 times the square root of the distance in miles. Mean sea level was used as the control datum.



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Valley cross-sections at 13 locations and 12 sections showing bridge openings were surveyed to show the hydraulic characteristics of the valley and bridges for flood-routing purposes. Reservoir area maps of nine sites were prepared by an SCS survey team using the planetable and telescopic alidade with a photo enlargement used for the base map. The maps were prepared using a horizontal scale of 1 inch = 400 feet and a contour interval of five feet. These maps were used to obtain stage-storage and stage-area data of the reservoir area as well as providing data required in preparing the land rights maps of the five dam sites shown on the project map.

Design

Preliminary design of the five floodwater retarding dams is in accordance with the design criteria contained in Engineering Memo SCS-27 (Revised), dated March 19, 1965. Structure classifications were made after a field review of the proposed structure locations.

Distribution of the expected 100-year sediment accumulation in the reservoirs was determined using the procedure outlined in TR-12 (Revised), dated January 1968.

Floodwater detention volumes for all sites were determined from computer routings of the principal spillway hydrographs. The minimum storage volumes determined from these routings were increased about 35 percent to realize a higher degree of flood protection for the city of Red Boiling Springs. Flowage easement elevations and the elevation of the top of the dams were set from routing the design and freeboard hydrographs. The emergency spillways are designed to function only from storms of a 100-year or greater magnitude.

The combined release rate from the principal spillway of all the structures is 577 cfs. This flow will not cause flooding downstream since the smallest channel section rated within Red Boiling Springs has a capacity of 580 cfs.

Hydrologic

Valley cross-sections were either surveyed or developed from quadrangle sheets at 22 locations. These cross-sections were used to develop water surface profiles using the computer program as outlined in EWP Technical Guide No. 22 for flood plains and constrictions. Stage-discharge, stage-acre, and stage-end area data, as required for flood-routing and economic evaluation purposes, were generated as output from this program.

In determining the maximum flood plain inundated and in developing a hydrologic model for watershed evaluation, rainfall distributions for the historical storms of January 6-7, 1946, and June 23, 1969, were developed from U. S. Weather Bureau publications, "Climatological Data" and "Hourly Precipitation Data." Rainfall data from the Corps of Engineers, TVA, and local residents were also used in this analysis. The storm distributions

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were used to generate local inflow hydrographs which were routed and combined to ascertain flood peaks and elevations at selected locations. The elevations were compared and were found to be in reasonable agreement with surveyed high water mark elevations.

The January 1946 storm began at approximately 8:00 p.m. on January 6, continued until about 7:00 p.m. January 7, and produced about 6.38 inches of rainfall. Although the 1946 flood caused extensive damage throughout the city of Red Boiling Springs, it is clearly evident that the 1969 flood was much more devastating. This storm began about 1:00 a.m. on June 23 and ended about 9:00 a.m. the same day. In a period of less than 8 hours, a torrent of about 9.00 inches of rain had fallen which resulted in what is thought to be the maximum flood of record. There are accounts, however, of similar floods occurring on May 19, 1842, and another one around the turn of the century.

Since the "Frequency Method of Analysis" was used in the watershed evaluation, several synthetic storms were also developed and routed. The runoff and/or frequency for each of these storms was determined from a partial duration series developed from an annual historical series. A 34-year period of record (1936-1969) was used in this analysis.

The runoffs were assumed to have occurred under an AMC III or a watershed curve number of 88. The rainfall necessary to produce the various runoffs was found to be in close agreement with the 8-hour rainfall amount as derived from the U. S. Weather Bureau Technical Paper 40 (TP-40). The synthetic storms were routed using the hourly distribution of the 1969 historical storm.

Routed peaks from the synthetic series for the ½, 1, 2, 5, 10, 25, 50, and 100-year storms were used as input data for the IBM 1130 Economic Computer Program.

Investigations revealed that even with the planned project installed, a flood equal to or greater than the June 23, 1969 flood would still cause damage in the city of Red Boiling Springs. This flood, however, has a percent chance of occurrence of less than 1 percent. The 1 percent chance flood (the 100-year peak discharge) will still cause flooding to a depth of from 2 to 3 feet in some areas of the city under project conditions. Only minor flooding may occur from a storm similar to the 1946 storm under project conditions since the major portion of the peak discharge would be contained within the channel. The 1946 flood has a magnitude equal to approximately the 10-year frequency flood.

It is not economically feasible to install project measures that would completely eliminate all flooding from the 100-year flood. Additional floodwater retarding structures above the city of Red Boiling Springs were studied, but none were found to be feasible. Channel improvement was also investigated, but any increase in the channel size would have resulted in large quantities of rock excavation. Fish habitat along the periphery of the stream would also have been destroyed, hence, only minor clearing and shaping as planned by the Open Space Program was evaluated under project conditions.

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Geologic

A field reconnaissance of the watershed was made to determine geologic formations present, stratigraphy of the formations, and their structural features. All available geologic maps and reports were studied to gain additional information on the geology of the area.

Preliminary geologic investigations were made at the proposed dam sites to determine geologic feasibility and to identify conditions which may require special design considerations. Investigations were carried out principally by observation of surface conditions, inspection of outcrops in stream channels, gullies, and road cuts, and by shallow hand auger borings at selected locations. Power auger borings were drilled along the centerline of the dam and in the borrow area of Site No. 2 and in the borrow and emergency spillway area of Site No. 1. The emergency spillway area at Site No. 5 was investigated with a portable refraction seismograph.

All of the proposed dams are located within the outcrop area of the Fort Payne Formation; however, the stratigraphy of the formation differs considerably from site to site. Silicious limestone underlies Site No. 1 with interbedded layers of argillaceous limestone, calcareous siltstone, and chert in the abutments. Site No. 2 is underlain by a green shale section in the lower part of the Fort Payne. Interbedded limestone, siltstone, and chert similar to those in the abutments of Site No. 1 are found at Site Nos. 3 and 4. Silicious limestone overlies the green shale section at Site No. 5. Weathered limestone, siltstone, and chert is present in the abutments. Bedrock is fairly shallow at all of the sites, although weathering has occurred to some degree in the argillaceous limestones, siltstones, and shales. There is evidence of solution channel development along joint and bedding planes in the silicious limestone at Site Nos. 1 and 5.

All of the proposed dam sites appear geologically feasible; however, special design features will be needed to overcome site deficiencies. Preliminary recommendations for foundation treatment were made for each site. These recommendations were used in estimating construction costs of the structures. Foundation treatment was based on individual site conditions. Final design data for P. L. 566 dams in Tennessee having similar conditions were used as a guide.

Recommendations included placement of cut-off trenches in competent bedrock and dentil grouting of exposed cracks and crevices in the rock. Blanket drains will be needed in the downstream sections of all the dams to intercept and control seepage along the surface of the bedrock. These drains will also be designed to relieve possible uplift pressures at Site Nos. 1 and 5. The need for sub-surface pressure grouting of solution channels in the silicious limestones at Site Nos. 1 and 5 is anticipated. This pressure grouting will be accomplished for the sole purpose of insuring structural stability of the dams.

Many of the solution channels in the foundation rock may be filled or partial filled with unstable residual materials. Water pressures may force these unstable residual materials from the voids in the foundation rock. Flow

of water through these solution channels may produce excessive seepage and uplift pressures which cannot be controlled by foundation drains. Subterranian erosion of residual materials in the solution channels could also occur and cause the overlying foundation rock to collapse. Uncontrolled seepage and deterioration of the supporting bedrock beneath a dam would greatly endanger the stability of the structure.

Sufficient quantities of borrow materials appear to be available within reasonable haul distances from the proposed dams. These materials are not overly abundant due to the shallow occurrence of rock in many areas.

The hilltops and slopes adjacent to the dams will provide the major source of borrow. Material types available will include CL, ML, and GC soils.

Extensive geologic investigations will be needed at all of the sites prior to final design and construction. Drilling equipment will be needed to sample and test foundation materials, locate solution channels in the foundation rock, investigate emergency spillways, and delineate borrow areas.

Sedimentation

Sediment storage requirements for the proposed floodwater retarding structures, sediment yield from the drainage areas above structures, and soil loss from sheet erosion were computed from procedures outlined in Technical Release No. 12 (Rev.), dated January 1968 and Technical Release No. 17, dated March 1966. The drainage areas of two evaluated structure sites were used as sample areas. Average annual sheet erosion rates were computed for each land use type. These erosion rates were considered representative for similar land uses in the drainage areas of the remaining structures and were used to estimate total sheet erosion. Anticipated changes in land use, land treatment, and cover conditions during the design life of the structures were taken into consideration in the computations. Soil losses from other sources, including gully, streambank, and roadside erosion, were estimated by field inspection of the individual areas. Gross erosion above each dam site was computed and appropriate sediment delivery ratios applied to determine the amount of sediment expected to be transported to the dam sites. Sediment delivery ratios were estimated using delivery ratio curves developed in the South Region as a guide. The structures are expected to trap 95 percent of the inflowing sediment. About 20 percent will be deposited in the reservoirs above sediment pool elevations and will be subjected to aeration and shrinkage. The other 80 percent will be deposited in the sediment pools and remain in a submerged condition. Volume weights of sediment under these two conditions were estimated and used to determine the capacity requirements for storage of sediment in the reservoir areas of the retarding structures.

Flood plain damage to farmland from overbank deposition of sediment was obtained from detailed investigations of the area. Damaged areas were mapped and the depth, texture, and composition of the sediment deposits were recorded along with the characteristics of the underlying soils. Crop production on damaged and adjacent undamaged areas were compared. All of these factors were considered in estimating reductions in productive

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capacities of the soils due to overbank deposition. These estimates were used in the economic evaluation to determine dollar damages. Estimates of potential recovery of these damages and recovery periods were made so recoverable values could be calculated. Reductions in overbank sediment deposition resulting from installation of the land treatment and structural measures were used to determine remaining damages and project benefits. These reductions were estimated for the evaluation reaches based on anticipated reductions in sediment yields. Soil losses from the various sources above each reach were obtained by expanding the data used in estimating the sediment storage requirements of the structures. Sediment source-sediment damage relationships were developed by the procedure outlined in SRTSC, EWP Technical Guide No. 12, Chapter XIV.

Reductions in overbank deposition due to installation of land treatment measures and structural measures could then be calculated based on reductions in yields of damaging sediment. The effect of the project in reducing the area and frquency of flooding was also taken into consideration in estimating total remaining damages and project benefits.

Flood plain scour damage was determined by field mapping methods. Widths, depths, and lengths of scour channels were noted. Exposed soils were compared with those in undamaged areas. Crop production was also compared in order to estimate loss in productive capacity. These losses were used to calculate dollar damages. Potential recovery and recovery periods were estimated for computation of recoverable values. Reductions in scour damage were based on the effect of the project in reducing depths and frequency of flooding in the various evaluation reaches. These reductions along with corresponding recoverable values were used to determine project benefits.

Fish and Wildlife

Studies and analyses were made by the biologists of the Tennessee Game and Fish Commission, U. S. Fish and Wildlife Service, and Soil Conservation Service working together and individually. The analyses included physical characteristics of the stream and watershed as related to the fish and wildlife resources, relative extent of fish and wildlife species, and population and relative hunting and fishing pressure and success. The extent and composition of the fish and wildlife resources in the Red Boiling Springs Watershed were determined by the Biology Work Group through interviews with local Tennessee Game and Fish Commission Conservation Officers and through observations and comparisons of this watershed with similar watersheds in Tennessee where intensive studies have been made.

Forestry

A systematic field survey showed ground cover, forest, and hydrologic conditions. This survey, supporting data, and information from these agencies and forestry officials served as a basis for the forestry recommendations.

Economic

The methods used in making economic investigations and analyses followed those approved by the Soil Conservation Service in benefit-cost evaluations on land and water resource projects. The methods followed are in accordance with instructions in the National Economic Guide. Basic data were obtained from property owners, agricultural workers, city, state, and county highway officials, experiment stations, and agricultural publications.

Basic information was obtained by interviews with property owners having land in the flood plain and consisted of the following: percent land use and yields; normal flood-free land use and yields; anticipated land use and yields with various degrees of flood protection; estimates of the present damage to the various crops and pasture by depths of inundation by months or specific flood events and damage to residential, commercial, and industrial property and other fixed improvements by depths of inundation or by specific storm events.

Adjusted normalized prices were used as a basis for benefit computation, cost of production, and cost of operation and maintenance. These adjusted normalized prices were developed from standards and criteria developed by the Interdepartmental Staff Committee of the Water Resources Council, dated April 1966.

A 1970 price base was used as the basis for installation costs. Land rights costs were developed in meetings with the watershed district sponsors. The unit costs of roads and bridges were developed in meetings with state and county highway officials.

The IBM 1130 computer was used to evaluate probable damages and benefits by use of the frequency method. A comparison of evaluated damages without and with the project installed was used to determine flood damage reduction benefits from input physical and economic flood characteristics and their frequency of occurrence. Output data provided benefits from alternative programs for use in project formulation and evaluation.

The watershed is in the Appalachia portion of Tennessee, and Macon and Clay Counties' eligibility under the Public Works and Economic Development Act of 1965 enables the use of benefits from increased employment as a result of the installation of project measures. The value of local labor used in project installation is estimated to be: (1) 30 percent of the construction cost; and (2) 50 percent of the annual operation and maintenance cost for the first 25 years after completion of project installation.

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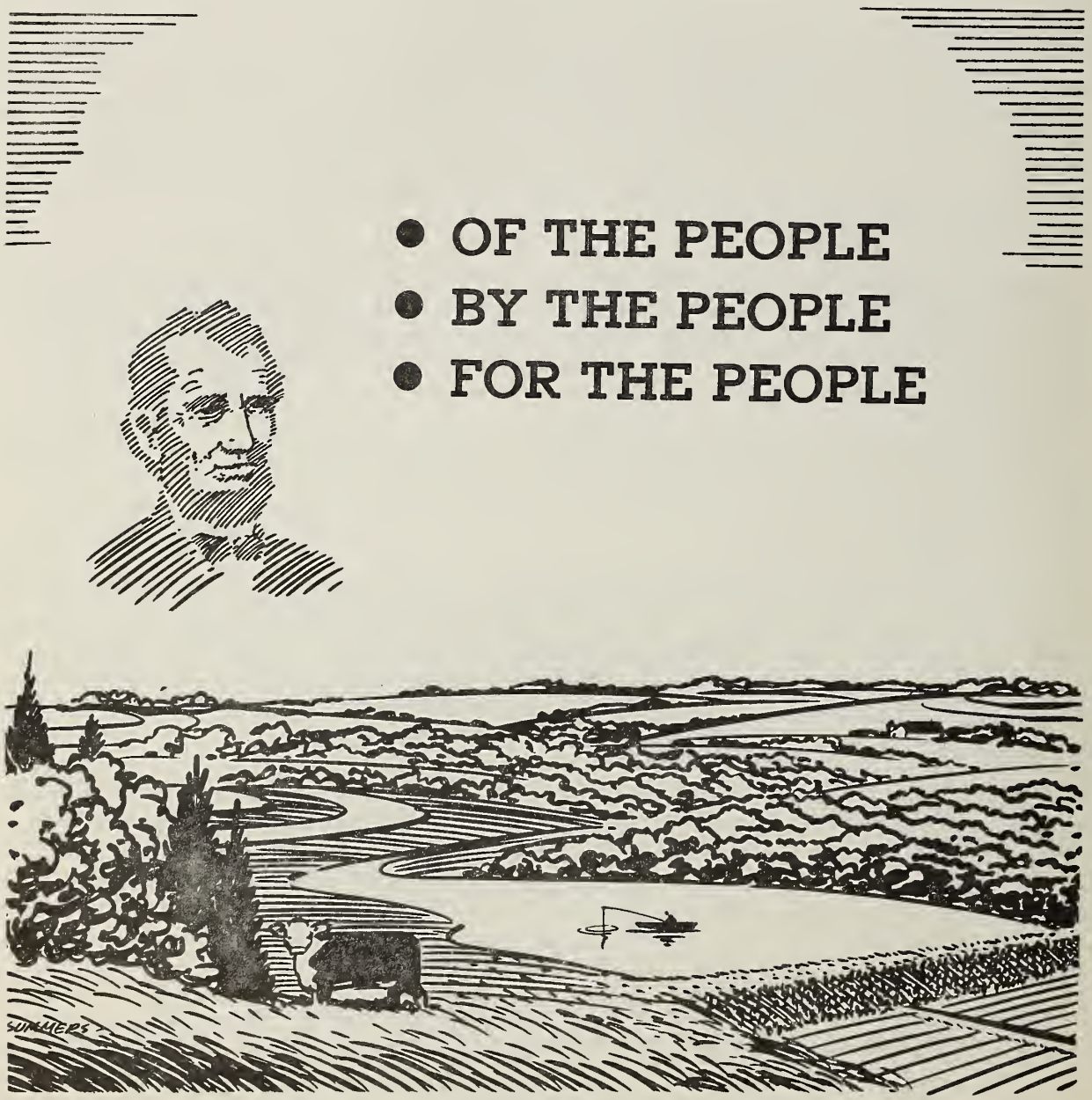
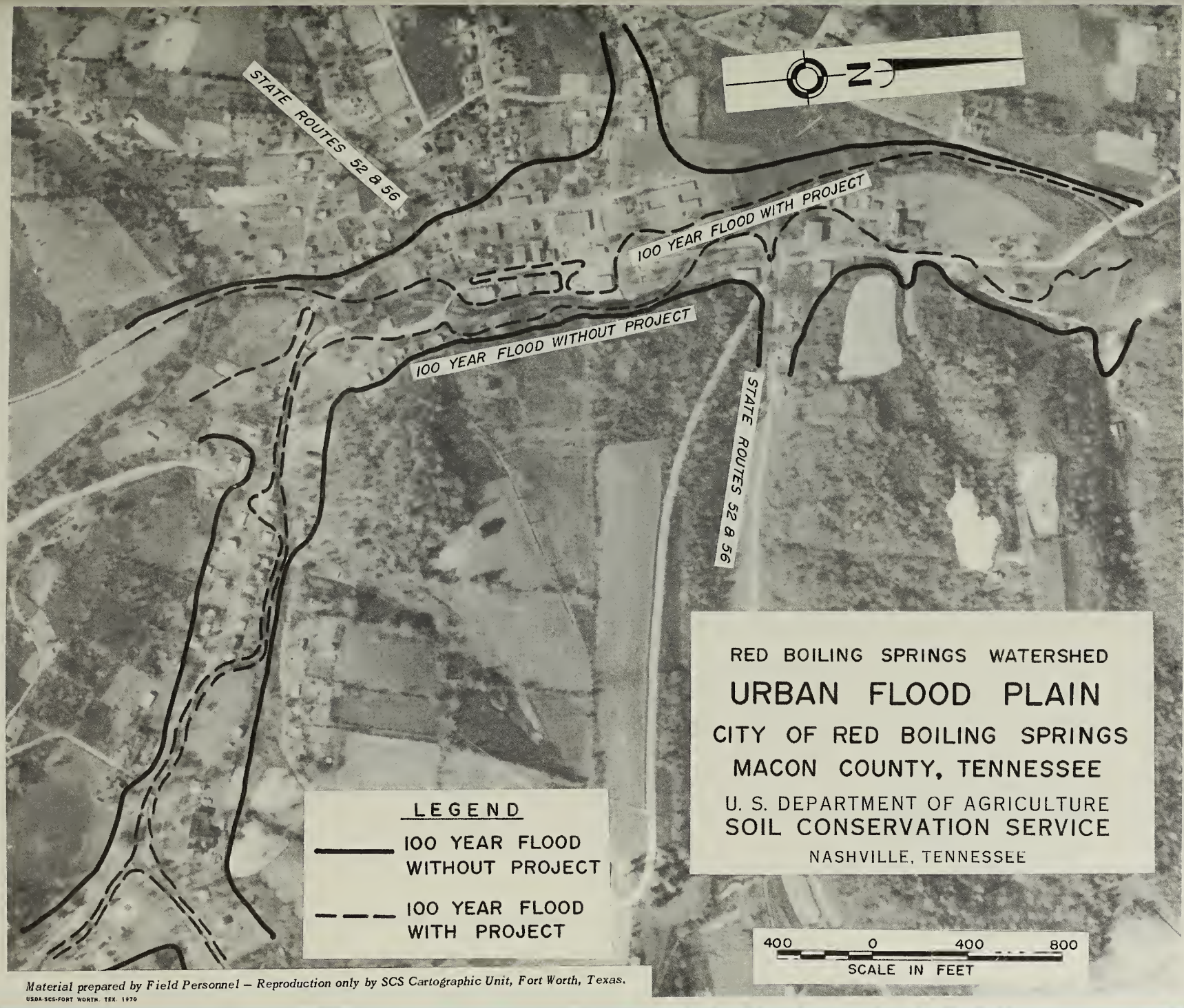
Local secondary benefits were evaluated as 10 percent of the direct benefits and used in project justification. Secondary benefits from a national viewpoint were not used in the evaluation or justification of this proposed work plan, although they will accrue.

Enhancement benefits from changed land use in the urban area of Red Boiling Springs were not evaluated, although land values will increase almost immediately with flood protection.





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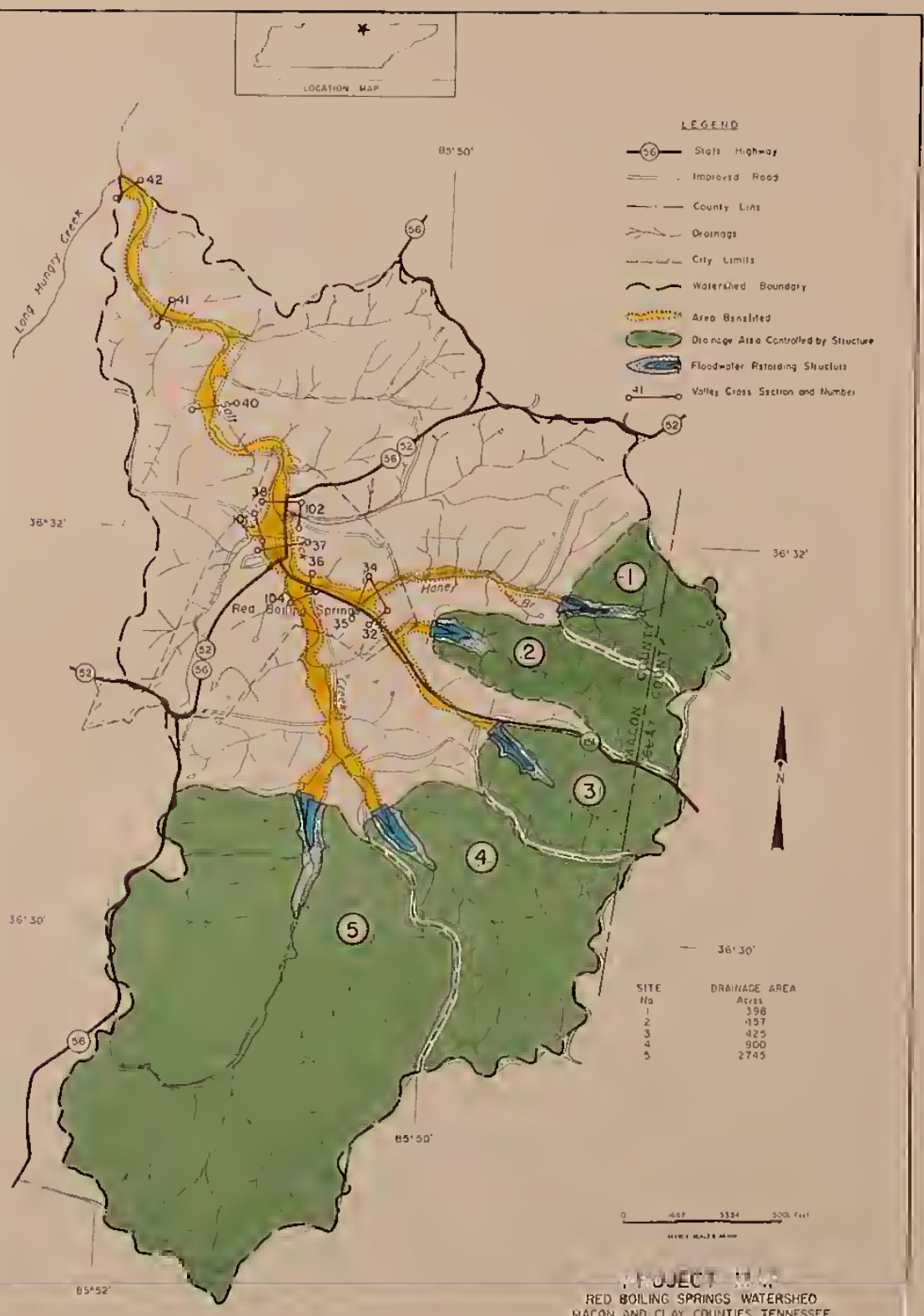
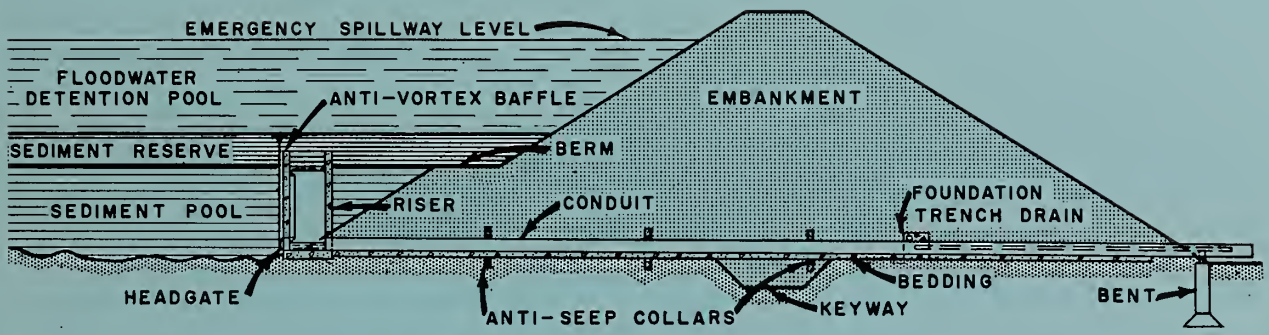

LOCATION MAP
LEGEND
State Highway
Improved Road
County Lines
Drainage
City Limits
Watershed Boundary
Area Benefited
Drainage Area Controlled by Structure
Floodwater Retarding Structure
Valley Cross Section and Number
Long Hungry Creek
Red Boiling Spring
Honey Br.
MACON COUNTY
CLAY COUNTY
85°50'
36°32'
36°30'
85°52'
SITE No. | DRAINAGE AREA Acres
1 398
2 457
3 425
4 900
5 2745
PROJECT MAP
RED BOILING SPRINGS WATERSHED
MACON AND CLAY COUNTIES, TENNESSEE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NASHVILLE, TENNESSEE
DRAINAGE AREA - 9650 Acres
12-70 4-A-30,032



SECTION OF A TYPICAL
FLOODWATER RETARDING STRUCTURE

(WITH SINGLE STAGE RISER)

USDA-SCS-FORT WORTH, TEX. 1970

I-67 4-L-23364